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Vol. III

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TRANSCRIPT OF RECORD

Supreme Court of the United States

OCTOBER TERM, 1938

No. 27

**THE TENNESSEE ELECTRIC POWER COMPANY,
ET AL., APPELLANTS,**

vs.

**TENNESSEE VALLEY AUTHORITY, ARTHUR E.
MORGAN, HARCOURT A. MORGAN AND DAVID
E. LILLIENTHAL**

**APPEAL FROM THE DISTRICT COURT OF THE UNITED STATES FOR
THE EASTERN DISTRICT OF TENNESSEE**

FILED APRIL 18, 1938.

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VOLUME III

INDEX

	Original	Print
Record from D. C. U. S., Eastern District of Tennessee— Continued.		
Statement of evidence—Continued.		
Evidence for defendants—Continued.		
Testimony of George R. Clemens	1008	1634
Edward H. Sargent.....	1063	1673
James S. Bowman.....	1074	1689
Sherman M. Woodward.....	1167	1772
Joseph H. Kimball.....	1229	1822
O. N. Floyd.....	1308	1887
Charles W. Okey.....	1328	1902
C. T. Barker.....	1373	1940
James S. Brodie.....	1471	2021
J. H. Alldredge	1493	2039

Record from D. C. U. S., Eastern District of Tennessee—
Continued.

Statement of evidence—Continued.

Evidence for defendants—Continued.

Testimony of—Continued.

Percy H. Thomas.....	1549	2084
Kenneth E. Hapgood.....	1612	2135
G. O. Wessenauer... ..	1654	2170
Charles L. Karr.....	1681	2192
James S. Bowman (recalled)....	1732	2233
Deposition of R. D. Cowley.....	1760-a	2257
K. T. Hutchison.....	1760-o	2269
Rebuttal evidence for complainants.....	1768-a	2284
Requests for subpoenas duces tecum.....	1767	2285
Testimony of R. W. Putnam (recalled).....	1769	2296
Theodore T. Knappen.....	1819	2338
Edward J. Minser.....	1836	2360
Joel D. Justin.....	1850	2373
Clarence Watson (recalled).....	1868	2388
Wm. P. Creager	1880	2400
Colloquy between court and counsel.....	1892	2414
Testimony of Jackson H. Wilkerson.....	1910	2433
Renewal of motions to dismiss.....	1917	2438
Statements re rulings of court.....	1917	2439

Judge Allen: His answer was no.

Q. Colonel, assuming you have one of the locks 60 by 300 feet, useful length, above Wilson Dam with a towboat towing eight barges as you have described, would you have to break the tow?

A. This is a lock on the high dam.

Mr. R. T. Jackson: Please, may I have a yes or no answer?

The Witness: Before I answer yes or no I would have to ask the question, that is what I was asking.

Judge Allen: Is it a lock 60 feet by 300 feet?

Mr. R. T. Jackson: A lock 60 by 300 feet useful length in the TVA Plan above Wilson Dam.

The Witness: Oh, yes. You have that in the report.

Mr. R. T. Jackson: Please, may I have the answer.

Judge Allen: Can you answer, Colonel?

The Witness: I cannot answer by an exact figure.

[fol. 969] Q. It does not call for an exact figure. Would you have to break the tow or not?

A. Yes, you would have to break the tow."

If you have to break the tow you would not have to go through that lock twice to get upstream. You would go through once with each part. You simply send half through the locks and then put the other half through, you don't come back and get the other half.

"Q. What takes it through, the towboat?

A. Oh, they could run in. When the tow approaches from above, it would shove it right into the lock, the first part, then you break the tow. Then you would either be carried out, you would either take your tow through first and run it out, or else run the boat out and get the other, or else run it by hand or machine or some other means. Now, if there were much traffic on the waterway it would pay to put in a machine to help carry through these breaking up of tows. It is practical and could be done readily, and could be done to help expedite the movement through."

You first break the tow and then after you get the tow through you have to get your tow together again and get

it under way. If you were approaching one of the locks in the low dam plan above Wilson, which would be 110 ft. wide by 600 ft. long, useful length, with a towboat drawing eight barges, it would not be necessary to break your tow.

"Q. That is the reason you recommended locks of that size when you made the recommendation on the low dam plan, wasn't it?

A. It was but a little part of the other delays in connection with the low dams, this balance of time due to double lockage.

Mr. R. T. Jackson: I submit he is not entitled to go over the whole case every time I bring up a point. Otherwise we will never get through.

[fol. 970] Judge Allen: Sustained.

Q. Now, Colonel, I invite your attention to a statement in House Document 328, exhibit 105, page 100, reading as follows:

'It is believed absolutely essential that in any high fixed dam there must be two locks in parallel to provide for dependable navigation.'

Did you ascertain from your examination of the high dams under the TVA Unified Plan whether any of them provide for two locks in parallel?

A. I think that I ought to be shown the book, the book you refer to. Never mind, right now. If I am wrong, why, go ahead.

Judge Allen: Well, do they provide for locks in parallel?

Mr. R. T. Jackson: Yes, the last sentence. My question—

The Witness: They are not now constructed, but the plans do contemplate or provide, if I am not mistaken, they have provision for putting it in whenever the commerce demands."

I have seen all the dams and sites in the TVA plans and I saw the places where you can put in another lock if you want to. There is room and they are great big dams. You can put several in if you want to. I know General George B. Pillsbury. He has been Assistant Chief of Engineers for sometime until recently, and a distinguished engineer.

"Q. Colonel Watkins, I direct your attention to the statement of General Pillsbury, testifying in the Ashwander case, page 670 of the transcript, wherein, after describing the time of lockage through high and low lift locks, he states—and I am quoting, following that through, 'And the Tennessee River between its mouth at Paducah and Knoxville, a very simple calculation shows that the additional lockage time required under that assumption, to pass through the river from its foot to its head would be nine hours and twenty minutes'; and ask you if you agree with that statement?

[fol. 971] Mr. Fly: I object.

Judge Allen: Objection sustained. The witness will not answer. You may have your exception.

Mr. R. T. Jackson: Let the exception be noted, if your Honor please.

Judge Allen: You could have called General Pillsbury, of course.

Mr. R. T. Jackson: I do not believe we could.

Mr. Fly: I will be glad to have you do that, Mr. Jackson. I will cooperate with you.

Mr. R. T. Jackson: I have had considerable experience with the Government for two years, your Honor, and they have refused even the request of the presiding Judge for the presence of an officer in the administration of justice, saying that is a rule the Government had adopted.

Judge Allen: The Court considers the injection into this record of testimony of a witness in another case, between different parties, as offering totally incompetent testimony, a different witness, not this witness.

Mr. R. T. Jackson: I understood that to be the ruling of the Court. I had not anticipated such a ruling, or, of course, I would not have offered it.

Judge Allen: That is the ruling of the Court, and the Court will doubtless adhere to that ruling, if similar situations arise.

Q. Colonel Watkins, you stated in your direct examination that at the upper end of the pools in the low dam plans, the pools would have very shallow water; will you please tell me what the depths in the upper ten miles in the Aurora pool under the low dam plan would be?

A. It is the navigable channel of the river, generally utilizes the greatest depth until it approaches the lock.

There you dredge a channel, from that point into the lock. It is common practice to make the depth of that channel to the lock say two to three feet greater than the navigable depth all the way up to the locks, so the controlling point at the upper end of the pools is generally that. Now, as to whether that applies to the particular Aurora Landing project, I would have to look.

Q. Your direct answer to my question is that you do not know?

A. No, that is not the correct answer at all.

Q. What is it?

[fol. 972] A. The correct answer is the one I gave, that is the usual and common practice, that is the way they do it.

Q. I am not asking about the usual and common practice, Colonel Watkins. Please tell me what are the prevailing depths in the Aurora Dam under the low dam plan?

Judge Allen: Do you know the specific depth?

The Witness: No, I do not, your Honor. I have explained that in my answer, and went ahead and explained."

I do not know the depth in the upper ten miles of the Aurora Dam pool under the low dam plan at low water without looking it up and the answer is the same as before. Depths in excess of 16 to 18 feet are valuable to navigation designed to use a 9 ft. project in increasing the velocity of the boats. Depths in excess of that amount are valuable.

"Q. What difficulties are involved in the salvage of boats, where the depths are 80 to 90 feet?

A. Well, if you have got a good pilot on the boat and anything happens, he sees a barge going down, I think it would be common sense to run to shallow water somewhere. Take the high dams, the deep part,—

Judge Allen: Your answer is that it is harder to get out, the greater the depth is?

The Witness: No, your Honor, it is not harder to get out, for the simple reason that all along the low dam system you have deep pools. You also have deep pools under the high dam system. If anything happens to your boat you would have to go down like that, it would go down in deep water, 80 per cent of the distance. Under both of them there is generally places where you can ground your vessel. I think that answers."

It is customary to allow from 2 to 3 feet over depth in dredging for a channel such as a 9 ft. channel. It is common practice, I think now, to have an additional depth over the 9 ft. up to about 3 feet, making about 12. That is what they [fol. 973] did on the Kanawha, I know. As to how many miles of channel of less than 12 feet would exist on the entire channel under the low dam plan with low water conditions and the amount of dredging which I have stated, there would probably be only the approach to the lock. There may be some bars below, where they approach that measure. Where you have to take the shallow approaches to the pool they constitute as a rule for various rivers,—I have not taken the profile and gone over them all, about 20 per cent of the total length. If we used something over 600 miles in the new section of the river, multiplying that by 20 per cent would give 112 miles under the low dam plan. That is not based upon an actual examination of the profile of the river which might result in a lower figure. It is an approximate estimate but reasonable enough. You can work it out if you want to. It is based on my study of a whole lot of rivers, including this one. It might apply to some other river a little more or a little less. If the river is at a 4 ft. stage the depths at the head of the pools would increase by approximately four feet. I do not think it is exactly true that the river is at a 4 ft. stage or greater for a substantial part of the time, not in its natural condition. In the upper end, just let me figure now, I have found out with re-regulation that we provided about 3 feet additional depth over these critical bars with all of the regulation I had. Now the average annual flow, not available 60% of the time, in the upper part of the river, I don't think is over about 3½ ft. up there over the critical bars. So you see it does not go up so very fast. That 4 ft. increase on the upper river, I doubt if it occurs over about 25 per cent of the time. I would say that it would be fair to say it would [fol. 974] range at least 30 per cent at Knoxville to 75 per cent down by the Aurora pool. We have better flow on the lower river.

I don't recall testifying that the increased towing efficiency that could be obtained with an increase in depth from 9 to from 13 to 16 ft. was 10 to 20 per cent, and I don't recall giving any estimate of increased towing efficiency by

reason of the greater depths that were increased to from 13 to 16 ft. as against 9 feet.

"Q. Well, what would you say that the increase in towing efficiency would be for depths that were increased to from 13 to 16 feet as against 9 feet?

Judge Allen: Now, Colonel, answer that question please, and then make your explanation.

The Witness: His question was what was the towing efficiency. I said we are now—I can show you a curve from which we can get down to the various depths and determine what they are. All right, now, this is the chart, or the curve. In explanation of this curve I will state that before I was on the survey on the Tennessee River and its tributaries I was engaged on the survey of a proposed waterway which ran from Toledo to Chicago. The controlling factor in that case was the speed—

Mr. R. T. Jackson: I object to this.

Judge Allen: Colonel, we are limited in our examination to this case. Now, from that case you doubtless got some experience on which you draw in testifying in this case. But confine your testimony, please to this case.

A. That is satisfactory. This chart shows the speed in miles per hour and in the horizontal line it shows the indicated horsepower—

Mr. R. T. Jackson: I object.

A. For the various speeds of boats.

Mr. R. T. Jackson: I object to the statement of the witness and ask that he be required to answer direct.

The Witness: I am answering it as closely and quickly and as positively as I can.

[fol. 975] Judge Allen: Can you answer the question and then explain your chart?

A. My curve here shows that boats operating at the same horsepower, under the same power, can travel at about—was that 16 feet and 9 feet?

Q. It is 12 to 16, I wanted to know what the differences would be for the range of from 12 to 16 as compared to 9?

A. Well, the whole range from 12 on up to 20, and deep water I have on this curve.

Q. I didn't ask you for that, Colonel.

A. Now, if I can pick it out—

Judge Allen: Give us from 12 to 16, Colonel, please.

The Witness: From 12 to 16 the towing efficiency is—it is 15 per cent."

It would be about 15 per cent for one of the higher speeds. The line I took it from was one using 10 miles per hour because the lines were subdivided. It would be slightly different in the lower one. The lower the figure you take, the less spread there is between the speeds but not necessarily the less efficiency.

"Q. Now, according then, as I understand your testimony on these depths, for somewhere around 20 per cent of the distance, for an average of somewhere around 50 per cent of the time, that is between 30 on the upper river and 75 on the lower, the depths at the heads of the pools will be somewhere between 12 and 16 feet and will probably average around 13, will they not?

A. No, I think I can explain very briefly the basis of my estimate so that it will be in the record.

Q. Please don't do that. You have several times.

A. No, it will not—I said so.

Q. All right.

A. I said no. Now may I explain as quickly as I can, so we won't delay this procedure any longer? I can give you just what you need for your records.

[fol. 976] Q. Please don't explain it again, so far as I am concerned.

Judge Allen: That is all right, Colonel.

The Witness: May I go ahead, your Honor?

Judge Allen: Not right now.

Q. Well, isn't it true, Colonel, that if the average increased speed resulting from this increased towing efficiency would not be over 15 per cent as you estimated, and when you take into consideration the actual depths that there will be over the greater part of the distance between Knoxville and the mouth of the river, the increased towing efficiency over all will be less than 2 per cent as compared with the 15 per cent that you stated in your direct testimony?

A. No, I do not agree with it in the least.

Q. You do not agree with that?

A. I would like, if I may explain briefly.

Q. The Court said—

Judge Allen: Now, just a minute. Well, all right.

A. This curve which I have here shows the increased speed which you can obtain.

Judge Allen: Now, does this relate to the Tennessee River?

The Witness: It relates to depths for any water-way your Honor, various depths. It shows for depths, various depths, the speed you would get for boats with the same power, for depths of 12 feet, for depths of 13, 14, 15, 16, on up to 20 feet, and on up to deep water.

Judge Allen: All right.

The Witness: There is your picture written right in there. You don't need all these detailed questions. They are written right there.

Judge Allen: All right.

The Witness: Now, with that in mind you have got a chart here which shows the efficiency for all these various depths. All right. Now, as I told you before the shallow bars over which the boats have to pass constitute approximately 20 per cent. Very well. 20—I mean now that amounts to about—Well, in the low dam system you have that in every [fol. 977] one of the pools and throughout the pools there are certain shallow depths. If you will notice while the increased depth of 12 to 13 or 14 feet will not be so much greater, the depth of water will be there. In the high dam pools you have got deep water throughout. You see, except in the upper, only in the upper and at seven places, I find seven, we have greater depths, you see.

Judge Allen: All right, Colonel, you have explained this chart."

The low dam system involving the use of movable dams prevailed throughout most of the Ohio River when they were first put in. They do not prevail throughout now, not entirely, because they are replaced with higher dams. I want to testify that we are at the present time replacing the low movable dams with high dams throughout most of the Ohio system. Today they are mostly movable low dams but we are replacing them and we have a few of them in. It is a fact that there are something over 50 low dams along the Ohio River and something like five or six have been replaced.

"Q. And about how many tons of commerce move annually on the Ohio River?

Mr. Fry: I object to all those details of the Ohio River. I wanted to go into that, your Honor, and if he does insist on it, I will withdraw my objection.

Judge Allen: Objection sustained.

Mr. R. T. Jackson. An exception will be noted.

By Mr. R. T. Jackson:

Q. What would be the force of that flood of 1926 on the difference in current velocities just below dam No. 1 under the low system and the Tennessee River Valley Unified Plan?

A. As I recall, the river just below the low dam system is subject—that would be the 1926 flood, the velocities there run approximately eight to ten miles an hour. Yet, we have got it all in the record—why don't we look at that.

By Mr. R. T. Jackson:

Q. Well, the short answer is you do not know?

A. My short answer is I have a very good idea of that from my knowledge of the river. Why is it necessary to ask me that, let us get it out of the book.

[fol. 978] Judge Allen: Now, Colonel Watkins, Mr. Jackson is entitled to examine you.

The Witness: Oh yes your Honor.

Judge Allen: You are supposed to answer the questions and if you cannot answer, say so.

Mr. R. T. Jackson: In many of these it is satisfactory for the Colonel to say he does not know.

The Witness: But I do know, approximately.

Judge Allen: His statement is that he knows approximately, that goes with the other statement.

Mr. R. T. Jackson: Yes. That is satisfactory too. I just want to get an answer.

By Mr. R. T. Jackson:

Q. Colonel, you testified that due to the characteristics of the TVA Plan, substantial economies would result to navigation by reason of the fact there would be less fluctuation in the elevation of the stream, and that the terminal constructions and properties, and their operation would be

more economical. What is the difference in changes in the level of the river, resulting from the low dam plan and the TVA Plan at Sheffield, Alabama?

A. Sheffield, Alabama is in the rapid section of the river.

Mr. R. T. Jackson: For my part, unless the Court wants to know, you can give me the figure. I do not care for the geography.

The Witness: I have to work it out, your Honor. When they ask an engineer a question, we have to work it out.

Judge Allen: You have to work it out?

The Witness: Yes, I am working it out, if he won't interrupt me.

Judge Allen: Do you have it here.

The Witness: Yes, Ma'am.

By Mr. R. T. Jackson:

Q. Have you it in your working papers?

A. I have it right up here (indicating).

Q. Are you working it out?

A. If you do not interrupt me and let me work it out.

Judge Allen: Let him work it out.

[fol. 979] A. That is a rapid section of the river. As I recall from memory, the rises in flood at that point is very small as compared to what it is for the rest of the river, therefore, for the 1926 flood I do not believe it was over, much, about 25 feet, something like that, where as on the lower river it ran about 50, and the mid-section, about 40 to 50.

Q. What would be the difference between the range of river stages resulting from the execution of the low dam plan and resulting from the TVA plan at Sheffield, Alabama?

A. That is the upper end of the Pickwick Landing dam, and in the low dam system, I believe of the Colbert Shoals dam, the upper end of the pools will probably be about the same, maybe slightly different. But, bear this in mind, that the high dam plan, you will have materially increased the depth available in the upper end of the pool. And from information which I have worked out on the other survey, of which I have got graphs here, that will materially increase the velocity in that portion.

Judge Allen: The question is, as to the difference in stages, under the low dam plan and the TVA plan.

Mr. R. T. Jackson: That is right, at Sheffield.

The Witness: It will be materially greater under the high dam system than the low dam system, due to stream regulation, offered by the high dam system."

I do not know but I can work out immediately the difference between the change in river stages resulting from the execution of the low dam plan and resulting from the TVA plan upon the terminal at Sheffield, Ala. I do not have it in my working papers. We do not have it worked out that way.

The answer to your question is that the engineers of the TVA have given me the answer and that is, with the high dam plan it would be 16 feet, and with the low dam plan it would be 16 feet. There would be no difference at Sheffield due to certain backwater stages at that point. I did not have that calculation in any working papers.

[fol. 980] On the same assumption I do not know what the difference would be at Florence, Alabama, but I do know that that is one of the places in the river where the fluctuation is less. It is much greater all up and down the river than at those two points. The difference at Florence would not be very great.

I do not think the difference at Knoxville would be very little. There would be quite a variation there because there is more difference in the natural stages. I have calculated it, it is written in the book. There is the differences in the book. I do not have it among any working papers that I have prepared. Such details as that I did not attempt to bring with me because it is not material to the questions at issue in this case. I do not have them with any working papers anywhere. It is in House Document 328 and I did not have to work it up. The difference between the ranges in the low navigation plan of House Document 328 and the TVA Unified Plan are shown in House Document 328. As to the fact that the TVA Unified Plan was promulgated in 1936, we have plans there that the dams are substantially the same. There is a slight difference. There may be slight differences here and there. The three ports of Knoxville, Florence and Sheffield would be relatively important ports on the Tennessee River.

I am familiar with the terminal at Danville on the Tennessee River. It is about 80 miles above Paducah and is one

of the best terminals on the river. I do not know exactly right now what will happen to the terminal at Danville when and if the TVA Unified Plan is carried out, but I do know that it is practical to provide good terminals all up and down the river, and unquestionably they would be provided. I know it will be lying under possibly 40 to 50 feet of water.

[fol. 981] The range on the Tennessee River is something on the order of 40 to 50 feet, maybe higher in some places. The range on the Ohio River is up to 80 feet and may be that high once in a thousand years.

"Q. Colonel, has the Corps of Engineers ever recommended the expenditure of three to four hundred million dollars to avoid any inconvenience to terminal operators upon the Ohio River by reason of fluctuations in the stage of the river?

Mr. Fly: I object to that, immaterial and irrelevant.

Judge Allen: Objection sustained.

Mr. R. T. Jackson: May we have our exception, if the Court please.

Q. Is it not a fact that the Ohio River, the industrial area which it serves and the commerce which it carries are very much more important than the Tennessee River?

Mr. Fly: Your Honor, I want to go into this. I do not want to mislead the Court. I want to go into it, a comparison of the rivers. I will be happy to do it. I won't make any objection to this question. I will leave it up to the Court.

Mr. R. T. Jackson: If I may say so, I asked the question to follow up the previous one, frankly, which the Court excluded, because it seemed to me whether the exclusion was material or not would not be apparent unless I followed up with this question. It may be within the Court's ruling, I think.

Judge Allen: Objection sustained.

Mr. Fly: I do not object, your Honor.

Judge Allen: The Court sustains the objection.

Mr. R. T. Jackson: May we have our exception then, if your Honor please?

Judge Allen: Yes."

Between Paducah and Pickwick Landing under the low dam navigation plan set out in House Document 328, as I

recall, there are bends and crooked channels, it is very straight generally, about every five or ten miles, and there are bars all along there too. I would say a rough estimate of 5 to 10 miles for the crooked channel parts and for the [fol. 982] bars. There would be interference along there. There would be a very few miles of crooked channel under the high dam system between Paducah and Pickwick Landing. With the high dam system boats could run straight.

"Q. As a matter of fact, there is not very much difference in that section, is there, by reason of the fact the crooked channel is largely the result of the river flowing between close bluffs, up to within 110 or 140 miles above the mouth?

A. There is considerable bend in the narrow part, as you go along there, in part as I recall. Of course, I could not sit here and point out all the details right now, but there are interferences in that section, as well as I remember, as well as others. You have all that in the record. You can look that up and see.

Judge Allen: Colonel Watkins, you have to answer the questions even if it is in the record.

The Witness: Yes, Ma'am.

Judge Allen: If the Court permits the question to be asked you have to answer."

The Gilbertsville pool is that one at Aurora Landing and the lake that will be created by it under the TVA Unified Plan will be up over the natural banks of the stream at normal pool level for a distance of 40, 50 or 60 miles, something like that. I have not gone into such minute details as that and could not answer whether it will be at least 85 miles under the TVA Unified Plan. I do not think it should be expressed that I am giving my testimony without having examined the Gilbertsville project, as incorporated in the TVA Unified Plan, to know the size of the lake created by the dam. I have gone into all of the fundamental details. This minor detail is not very important so far as the total is concerned. When I considered the effect of wind and [fol. 983] wave action I did not ascertain how long or how big the lake created back of Gilbertsville Dam would be. I did not look it up because that is not necessary. I am very familiar with that river and I know the channel is very

narrow as compared with the total overflow area. You would not have much wave action on that shallow part.

"Q. Assuming, Colonel Watkins, that the water would be over the banks at the Gilbertsville Dam for a distance of 85 miles, and there are distances of five to ten miles, as you have testified, in the pool above Gilbertsville Dam which are perfectly straight; how is it you find such difficulties under the TVA plan in comparison to the low dam plan as to cross winds blowing tows from their course in crooked channels?

A. For the simple reason that the low dam plan, the channel is generally narrow. There are restrictions, and you cannot utilize the whole width. When you go over the bars you have to keep generally at about one place, and in the high dam plan, like I have explained, in the high dam system you have a great big wide pool with no particular velocities and it makes an enormous difference."

The width of the lake produced by Gilbertsville Dam at miles, 30, 40, 50, 60 and 100 at normal pool level would be about a mile. All of the testimony I have given has been upon the assumption that the width of Gilbertsville Lake will be about a mile at those points at normal pool level. It is immaterial whether it is much wider because it is shallow out on the other part except just about 1,000 feet. Shallowness makes an enormous difference in the size of a wave. It makes them smaller and holds them down. I [fol. 984] am quite familiar with the approximate width of the channel under the low dam plan embodied in House Document 328 at those same points. The width of the river there varies from about 1200 to 1500 feet or something of that kind.

"Q. And therefore,—I presume under the low dam plan, the widths at those stations, miles 30, 40, 50, 60 and 100 would be somewhere between 1200 and 1500 feet, is that right?

A. No. I have got the book. I know what it is. That is what I base my testimony on, is the accurate information. You asked me for an absurd estimate right now, when we get all of this other in. I can give you an approximation of it, but I don't see that it does any good.

Judge Allen: Now answer the question that was asked Colonel, please. Is that your testimony?

The Witness: No, that is not my testimony, your Honor.

Q. Then what is your testimony as to the widths at those places under the low dam plan?

A. My testimony is based on information which I have already given you that there are bars along the river, there are certain points that you have to go over those bars, and the channel bends in certain places, and all of those features, that is what it was based on.

Judge Allen: The question was not what your opinion was based on, the question is what were the widths at those places.

A. I don't know exactly, your Honor, right now.

Q. All right.

A. But I have got it recorded. I don't know exactly what they are."

There is not a substantial difference between the effectiveness of winds blowing across a few miles of narrow channel protected by high banks or trees as in the low dam navigation plan of House Document 328 and that of winds blowing across open stretch of lake two or more miles in [fol. 985] width as in the Gilbertsville Lake in the TVA Plan. In the low dam system that navigable portion of the stream is much narrower and although there may be high trees along the bank, in a boat which sticks up a considerable distance above the water, in general almost as high as the bank in places, it will be blown out and I say that because I travelled up and down that river many a time and very frequently I had to stop and tie up during winds. Protection from higher banks and waters along the shore of an inland waterway will help if the wind is from a certain direction but it will not cut it off entirely because you cannot always keep right along those trees because the navigation channel at points is over on the other side.

I have never personally managed a commercial inland waterway company. I don't think it would be fair to say that actually disregarding the waves, the wind action on the Gilbertsville Lake will be worse for navigation than it would be for the same stretch of river under conditions that would prevail under the low dam navigation plan. I

think it would be a decided advantage in the case of the high dam because you have got a wide enough river to operate on without any fear of being blown out of the channel in the high dam system, but not so in the low dam system. I have heard of harbors of refuge and I never heard of any being placed on a narrow channel or being placed anywhere except along the Great Lakes. Harbors of refuge are for the purpose of giving shipping a place to go during winds and waves. I had worked out a number of these on that project up there. I don't know that it is a fact but it may be that complaints and troubles are now being experienced and harbors of refuge are being demanded on Lake Peppin on the upper Mississippi River.

"Q. And isn't it a fact that the Lake Peppin is simply an enlargement of the Mississippi River, about 18 to 20 miles long, and 1 to a maximum of 3 miles wide between close-lying, high bluffs, covered with timber?

A. I cannot give you all of the facts. I do know that—

Judge Allen: Just a minute, please. The Court considers that we should confine the inquiry to the Tennessee River.

Mr. R. T. Jackson: I am only making this inquiry to test the knowledge of the witness, as your Honors will appreciate.

Judge Allen: Well, we go far afield sometimes in that test.

Mr. R. T. Jackson: I did not mean to argue, I just wanted to state the purpose of my inquiry. May we have our exception?"

It would not be necessary to load river equipment somewhat lighter on account of wave action on these wide waters under the TVA Unified Plan if you would provide protection to keep the water from flowing over an open barge. In a barge with the top covered, if you load your loading properly, it would not hurt anything for the waves to pass over it. One way of providing protection against waves going over an open barge is to load it lighter. With a little initiative on the part of the manager of the company you will know very readily that that will cause a great loss in the load which it can carry and by simple devices which he can readily provide to prevent these waves from going over he can still maintain the load that he can carry without any loss whatever. I do not know as a matter of fact

in practical commercial operation whether or not they do load lighter under such circumstances.

[fol. 987] I do not really think it would be necessary to increase the structural strength of the river equipment so as to withstand the stress due to excess wave action. I have never had any business experience in obtaining certificates from the American Bureau of Shipping qualifying vessels engaged in commercial transportation operation for marine insurance.

"Q. Colonel, I direct your attention to the testimony of General Pillsbury, at the hearings before the Committee on Military Affairs, House of Representatives, 74th Congress, First Session, on page 302 as follows:

Mr. Fly: May it please the Court—

Mr. R. T. Jackson: May I complete my question?

Mr. Fly: I object right now. It is just another way of getting hearsay before this Court.

Mr. R. T. Jackson: I don't think that is true.

Mr. Fly: There is no proper purpose in reading General Pillsbury's testimony.

Judge Allen: Just a minute. In what capacity was General Pillsbury appearing?

Mr. R. T. Jackson: He was appearing in his official capacity before the Committee to advise the Congress under his oath of office, which, as I understand it, makes his statements perfectly competent in any court.

Judge Allen: The objection is sustained. You may have your exception.

Mr. R. T. Jackson: May I complete the sentence or question for the purpose of having the record show what the question is?

Judge Allen: How long is it?

Mr. Jackson: What I want to read is 3½ lines.

Judge Allen: Yes.

Mr. R. T. Jackson: Carrying on to the other question:

'General Pillsbury: Yes—Oh, yes, high dams'—this is with relation to the Tennessee Valley Authority,—'are very much more costly than the low ones. They are not better for navigation, but the justification for their large expenditure can be found only in the power that they make available.'

[fol. 988] That is the end of the quotation. And I ask you whether or not you agree with the opinion of General Pillsbury. Now, the Court sustains the objection to that question and I ask that our exception be noted."

I testified on direct examination about certain low dams on the Kanawha River which were being replaced by fixed roller gate dams with lifts not to exceed 28 feet, and these dams were quite old and the time had come to replace them. As a matter of fact they were built somewhere between 1888 and 1898 and some of them needed considerable repairing. The width of the pool just above each of the new dams constructed or under construction on the Kanawha River is not much wider than the low dams because it is all confined to the river channels.

The fixed dams that I refer to on the upper Ohio are all low enough that the pool is confined within the river banks. I am not familiar with the exact width of that. I have seen the dams but I did not go along to try to look at the pools. I would not want to testify that any of them create pools that overflow the river banks but, as I recall, the Ohio is much wider than the Tennessee.

I am still in agreement with the following statement in my report in House Document 328 (Complainants' Exhibit 105 in Paragraph 79 on Page 100:

"As indicated above this system of low dams will provide for navigation only. There will be no benefits to flood protection and no power, except a very small amount for the operation of the dams themselves will be developed. The plan, however, will provide a waterway comparable in every way with the improved Ohio and adapted to incorporation with a consolidated inland waterway system of nine foot depth. On such a waterway, large tows of from 10,000 to 16,000 net cargo tons can be transported at costs, depending upon quantities and facilities offered, of from 1 to 2 mills per ton-mile."

[fol. 989] House Document 328 on page 100 at paragraph 80 does not exactly state my opinion correctly:

"The District Engineer believes that no lesser project will provide an adequate waterway for modern barge traffic, and therefore believes that if there be any modification of the plan by the substitution for any two or more low dams of a high dam to develop power or provide flood protection,

that the capacity of the waterway for the economical movement of modern barge traffic, should not thereby in any way be lessened. It is believed absolutely essential that in any high fixed dam there must be two locks in parallel to provide for dependable navigation."

There is a material difference of opinion on that idea. When the report first went up I had the single lock with provisions for additional locks of the same size or 600 feet, but when it went up before the various reviewing authorities, the Chief of Engineers himself mentioned that, without mentioning that it would be unwise to spend so much money now, putting a small lock in at the same time when the size of the single lock, 60 ft. by 360 ft., would meet all present demands, and that the double lock should go in in the future, that is, words to that effect. The Chief did not recommend that the low dam program should only be constructed progressively and with regard to economic conditions. The Chief of Engineers recommended that it be adopted by Congress but he did concur in my recommendation that we have a definite program of ten years in this development.

"Q. When you made the report of which I just read you a part, Colonel, you stated it was not exactly right, did you not, acting under your oath of office, correctly and accurately, report to your superior officer, and to the Congress what you believed to be true?

A. We are required to obey orders of superior officers and the division engineer instructed me to put words in, to approximately that effect. We were endeavoring to get a report up to Congress to be adopted and he instructed me to modify the report. As I informed you, the report had [fol. 990] gone up once, and in order to get a practicable plan for cooperating with the power people in bringing that about, the latter part of my report was changed. I was directed to go up to the division engineer and draw up a plan with him. That was his idea against my very strong objection at that time to putting it in, because it is not wise and economical to spend that much money. However, he told me to put it that way, and I put it that way.

Q. Colonel, I also direct your attention to this statement which is over your signature at the top of page 101:

"It is recommended that a project for the progressive improvement of the Tennessee River from its mouth to Knox-

ville, by a system of movable or low fixed dams and by locks of Ohio River standards be adopted to be completed within a period of 10 years at an estimated cost of \$75,000,000 at the rate of \$3,000,000 for the first year and \$8,000,000 for each year thereafter until completion, with \$40,000 for annual operation, care and maintenance for each dam and pool; with the proviso that under the provision of the Federal Water Power Act there may be substituted for any two or more of the low dams herein provided for, a high dam if the resulting cost to the Federal Government will be less than by the estimate herein for the low dams, thus rendered unnecessary, and provided further that the capacity of the waterway for the economical movement of modern barge traffic will not be in any way lessened'.

That was your recommendation to your superior officers and to the Congress, was it not?

A. Yes, that was the project that we adopted in order to provide a simple measure for Federal Government cooperation with the power companies. And the report clearly shows we desired to have constructed the high dam system. There is no question about that. It is shown in the report.

Mr. R. T. Jackson: I move to strike out the last statement as not responsive, and as an argument.

Mr. Fly: I think it is quite responsive and a proper explanation of that sort of excerpts of the witness having been torn out of the book that way.

Judge Allen: The motion is overruled. It may stand.

Mr. R. T. Jackson: May our exception be noted, please?"

[fol. 991] In my direct examination I stated that a restriction should be placed upon the maximum draw-down of reservoirs on the navigable tributaries of the Tennessee so that navigation could be conducted. With respect in particular to Norris Dam I have not looked up the detail in the TVA report as to the difference in elevation between maximum pool level and maximum draw-down. In our proposed dam in the report it was 220 feet. I think our draw-down, was 80, something of that nature. It is in the record. I could not say right now whether it is greater in the TVA Plan. It is in the records. I have not worked it out on any profile and cannot tell what the maximum length of pool at Norris Dam would be at normal elevation and what it would be at maximum draw-down. As to

whether there would be a very considerable difference in the length of the pool, I do not believe there would be in per cent. There would not be a difference of so awfully many miles. I do not know the total length of the pool. I know that the profile between that point goes down very steep and that is why I answered you that way. I don't know exactly what it is.

I stated that wide fluctuation in stage would be a serious handicap to the operation of terminals on the main river and I stated the contrary with reference to tributary reservoirs. It is not a fact that construction and operation of terminals designed to overcome fluctuations of wide variation on tributary reservoirs, which would be as much as 75 to 100 feet, would be excessive and expensive. It depends upon the facilities which you provide for loading and unloading. It would require a special type of unloading equipment [fol. 992] ment for that purpose and the article which you desire moved. It would not be a serious handicap on the reservoir. It could be readily utilized for navigation. The operation of terminals on the main river with a much lesser fluctuation would not be simple. All you have to do is to look at the hydrograph of the river. You see it bobbing up and down throughout the whole year, whereas in Norris Dam there is only one slow draw-down through to January or February, and then a slow rise. The operation of Norris will be a filling of it during the winter season, then it will be kept flowing during the low water season and it will drain down for power. It will be filled during the major floods in December and January.

Under the operation of Norris Dam they have set aside a zone in the plan of considerable depth for flood storage there. Now just exactly how they will operate that I don't know yet. You can get that from the TVA's. I assure you there will be no such fluctuations in the Norris pool as you have all up and down the river with low dams. Flood storage at Norris is another thing I didn't know about on direct examination and don't know about now, but I refer you to the TVA. In the 1936 report there is information on it. The way I look at these things, engineers do the work, they draw up the plans and there is more ways to kill a cat than choke it to death on hot butter. They all go ahead and work out the things and know exactly how it will work out, according to their plans. They are not worked out accord-

ing to power load. These are primarily for navigation and flood control.

I agree with the statement in House Document 328 (Complainants' Exhibit 105) on page 96 as follows:

[fol. 993] "Power and storage reservoirs which may be constructed on this stream before the 9-foot waterway on the main stream is extended to the mouth of the Clinch should provide for a right-of-way for navigation and be so designed and constructed that they will permit the installation of 9-foot navigation facilities as soon as required, and until such navigation facilities are installed the power companies should pass loose logs over the dam free of cost."

I made an estimate of the cost of construction of a barge lift at Norris Dam and I assume it would not be constructed until navigation went up. I estimated it would cost some three to four million dollars, something like that. It is in the report. I do not remember the exact space lengthwise of Norris Dam which would have been required for the barge lift contemplated by me. The only way it affected Norris Dam was that I contemplated putting in a gate or a place for a gate. Just exactly how it would be handled depended upon the engineer constructing it. It went over the dam. The barge lift would be 60, 70, 80, 90 or 100 feet wide or something like that. I won't say 100 feet would be about right. I do not have the record. I just said it would be somewhere about 60 to 100 feet.

Assuming it is 100 feet wide, there is room for the installation of a barge lift at Norris Dam. They can go ahead and put the barge lift over there, take out a section, or put it inside, there are many ways to provide for that navigation. I cannot say exactly whether or not the location of the power house would necessitate the location of the barge lift in a section of the spillway. I have looked at where the power house is when I was there. I saw it was practicable to put in a barge lift when the time became necessary or other means of putting navigation through. I know where the power house is at Norris Dam and it is on the left side as you come downstream. You could not put the barge lift above the power house. There are different ways you can [fol. 994] put that on there. You can go ahead up a valley a mile or two from Cove Creek, put a barge lift in and bring barges through there.

"Q. Do you mean you might construct a canal from the lock, back of Norris Dam up some ravine to the river?

A. I mean that to illustrate there are plenty of ways to carry navigation from the pool above down to the river below.

Q. The only way you suggest is one that could not be carried out at Norris Dam?

A. We can very well arrange to carry the boat right up over the dam, if necessary, and down on the other side.

Q. Did you find a place for it?

A. You have plenty of space. I have testified there is space you can put it.

Q. You have testified, you cannot put it in the power house.

A. You could put it over the power house, if necessary."

If you installed a barge lift in a section occupied by the spillway, the effect on capacity of the spillway would depend on how high you put it. You can put one to carry the boats right up over the spillway and all. It is a detail any good engineer can do to put one over. A good engineer would fix it up so that depositing the barges from a barge lift in the cross currents resulting from the overflow of the spillway would not bother. That can be done. No great amount of ingenuity would be required at Norris Dam.

The river at the foot of the dam is some 400, 500 or 600 feet wide, maybe less. You have got it in the record. I have to say I do not know the exact figure of how wide it is. I would not want to say it is over 300 feet. It is not necessary to remember that.

[fol. 994-a] The following is a correct reading of the comments of General Spaulding, my superior officer, from page 498 of Complainants' Exhibit 105, House Document 328:

"Consideration of Ohio River statistics indicates that the district engineer's estimates of river tonnage and savings [fol. 995] are too optimistic. While the estimates for the Tennessee River have not been studied in detail, the general method that has been used omits many practicable considerations that enter into the economics of river-rail shipments, some of which are as follows: Collection of freight into large units for barge loads, and barge fleets, giving consideration to regularity of movement and time requirements of shippers. Loss of time by diversion of freight from rail

to river after haul is partly completed by rail. Deterioration due to additional handling at river-rail transfer. Effect of diverting freight from railroads upon their load factor revenues and rates."

I would like to call attention to the above quoted paragraph which reads: "While the estimates for the Tennessee River have not been studied in great detail," and make a little explanation. I do not agree with General Spaulding's statement. In the first place, he indicates that he has not made a detailed study. In the second place, he compares the commerce on the Ohio at a time before the low dam system of the Ohio was completed, by several years. During that time I was there and I would go up to the Division Engineer office and the Division Engineer would be busy all day answering calls from boats which were delayed and asking to please send a wave down to get them off the bars. So that navigation on the Ohio then was not what it would be with the completed system. So, his comparison with the Ohio commerce, into ton mileage and other factors, is not a fair basis for the waterway on the Tennessee, completed with no interruption to traffic and no delay, etc., and with a much deeper channel throughout than with the Ohio with the old low dam system then uncompleted. So, you would have a correct picture of the commerce on the Ohio at that date. Further proof of that is that since 1925 the commerce on the upper Ohio has increased enormously, for the length of haul. For the ton mileage on the upper Ohio, it has increased right along the lines which I have been predicting for the Tennessee River.

The following is a correct reading of the statement made by the Board of Engineers for Rivers and Harbors in paragraph 34 of House Document 328, which reviews my report;

"For the year 1926 the district engineer reports that there was a rail movement of 9,000,000 tons, which could have been handled more cheaply by water or by rail and water if a 9-foot waterway had existed from the mouth of the Tennessee to Knoxville. He estimates that the use of such a waterway for this movement would effect a saving of \$12,000,000 in the cost of moving this freight. While admitting that for various reasons, not all of this freight would actually have moved by water, he believes that 60 per cent of it would have moved in this manner and that the

actual saving in transportation costs would have been \$7,300,000. The Board concurs with the division engineer in the view that this estimate is excessively optimistic."

I would like to explain that. The Rivers and Harbors Board did not call me before them to discuss any of these details. So, I was not able to give them full and complete information which I had made, when I got down to the fundamental facts in the case. They took more or less the recommendation of the division engineer. In order to indicate how conservative those estimates were and in answer to Colonel Spalding's statement about delays in changing from the manufacturing systems to the waterways and so forth, that estimate of 60 per cent which I made of the total, which I indicated is economically feasible, is about the same thing as to say to the railroads,—you may have all of the 1926 commerce, we will not take a bit of it. You may have two-thirds of the total increase in commerce. All I am estimating for the waterway is one-third of the increase.

The report also shows that the increase with industrial development is going to be much greater, that is comparison 40 per cent to 100 per cent in ten years, so that the railroads [fol. 997] with two-thirds of the increase and the other large percentage of increase, are going to be carrying much more valuable freight than they will be before the development. While at the same time, the waterways can be carrying the heavy commerce for the industrial development, for manufacturing, ores, coal, the other minerals and forest products, and all other products.

"Q. Colonel, I direct your attention to one more statement by the Board of Engineers, on page 20 and top of page 21, 'the industry, agriculture, and commerce now existing or reasonably prospective do not, however, warrant the expenditure of \$75,000,000 for a project for the improvement by low dams which is the basis of the recommendation of the district engineer'. I will ask you whether or not I have correctly read that report?

A. Yes, you have. Will you also read the recommendation of the chief of engineers, who was the final deciding authority, or may I read it.

Mr. R. T. Jackson: We read it before the Court, before you came.

The Witness: May I read it.

Judge Allen: It is in the record.

Mr. R. T. Jackson: Yes, we read it the first day, I think, your Honor.

Judge Allen: It is not only in that record, but in this record.

Q. When you testified on yesterday you stated you allowed for interest and amortization $4\frac{1}{2}$ per cent, in computing the justifiable expenditures for improvement of the Tennessee River. What per cent, if any, did you allow for maintenance and operating costs, and what for depreciation?

A. I do not believe I gave that in my report, and in my estimate. I do not remember about the report.

Q. I did not ask about the report, but did you testify that yesterday?

A. Well, I testified as correctly as I can.

Judge Allen: The question is, did you testify to that.

[fol. 997a] Q. The question is did you allow a percentage for maintenance, operating cost or depreciation?

A. We have no percentage, your Honor. The way we work it out in the Corps of Engineers is this way, we get the percentage of interest and amortization, for the replacement of equipment which corresponds to depreciation in ordinary statements, for maintenance, operations and dredging up above and down below the lock we put in a flat sum for it, like it is indicated by experience. Our estimate is clearly shown in the report, 40,000 for each of the dams.

[fol. 998] Q. On yesterday you made an allowance of $4\frac{1}{2}$ per cent for interest and amortization, but you did not make any allowance for maintenance, operating cost and depreciation?

A. We do not work it out in that way.

Judge Allen: Well, did you or didn't you?

The Witness: No.

Judge Allen: You did not make a percentage allowance?

The Witness: No, we do not make it that way.

Judge Allen: You say you make an allowance?

The Witness: Yes, indeed.

Judge Allen: In another way?

The Witness: Yes.

Q. Is that included in the $4\frac{1}{2}$ per cent?

A. No.

Q. Is it additional to the 4½ per cent?

A. Yes."

I testified on direct examination, based on previous increases in railroad traffic, that I estimated by the year 1950 there would be such a growth in transportation that the water traffic by that time on the Tennessee River will be 2.3 times the amount estimated at the time of my report in House Document 328. I had made a study of the rail traffic and my estimate in that report was based on the previous increase in rail traffic. I do not know exactly what the increase in rail traffic has been in the southern region between the time of the preparation of House Document 328 and the end of the year 1935. As to whether there has been a decrease of 45 per cent, I would not be surprised if there has been a decrease. I looked at it for the last few years. Last year I know it did make a decided drop. I had not checked [fol. 999] that before I testified. I had a much better basis than that, the inland waterway system itself showing the commerce right on our rivers. I do not have the percentage of increase right now which would be required from now on to reach the figures I predicted in the year 1950. The figure is 2.4 times the 1926 figure. I estimated the increase by 1950 would be 40 per cent in ten years. It is my testimony now that I estimated the increase by 1950 will be at the rate of 40 per cent in ten years. That makes for the first ten years, 40, the next 80, and the next 120.

"Q. Ten years will take you to 1947, so you will have a little more than 40 per cent, somewhere around 60 would be about liberal, is that right?

A. No, my estimates were from 1926, ten years each.

Judge Allen: The question is, what would be the increase from now.

Mr. R. T. Jackson: Yes, in order to reach his 1950 estimate, taking into consideration his comparison of 1926 has now a decrease of 45 per cent, I want to find what increase in percentage he would have to have to reach the 1950 figure.

The Witness: I don't know exactly. It can be worked out."

I don't know whether 435 per cent would be about right. I testified yesterday the increase on inland waterways indi-

cated that they recovered from the depression and my estimate was approximately correct.

I base my present estimates for increase in traffic to 1950 on the trend shown on Defendants' Exhibit 30, the inland waterways chart, and on the additional information I got from the Chief of Engineers showing the increase in commerce up to 1936.

The total traffic shown for the inland waterways system in 1934, as shown on Defendants' Exhibit 30, is 214,000,000 [fol. 1000] tons. There is some difference in the figures shown in Part II of the report of the Chief of Engineers, U. S. Army, for 1935, which contains on pages 2 and 3 a statement entitled "Commerce of Rivers, Canals and Connecting Channels during the Calendar Year 1934", which reads as follows:

"The gross total commerce on the rivers, canals, and connecting channels was 215,146,078 tons, valued at \$3,973,683,002, which included 608,515 tons of foreign imports valued at \$18,983,258, and 644,331 tons of exports valued at \$42,937,637. After eliminating all known duplications of traffic between different rivers, canals, and connecting channels, the adjusted total amounted to 194,786,428 tons, valued at \$3,462,517,009."

Apparently there is a discrepancy of 20,000,000 tons. I would say offhand that this is likely to be more correct because it has been gone over and compiled by the statistical section of the Rivers and Harbors Board. I would not think that this elimination of duplication in the official report of the Chief of Engineers was incorrect. I do know I was informed by the Chief of Engineers that I could utilize this data and it was correct.

"Q. Colonel Watkins, I direct your attention to the tables in the Annual Report of the Chief of Engineers, Part II, for 1935, as follows: Page 20, Hudson River, 5,696,331 tons; page 21, Potomac River, 2,556,602 tons; page 22, James River, 1,873,471 tons; page 25, Sacramento River, 1,183,654 tons; page 25 again, Columbia and Lower Willamette Rivers, 4,903,508 tons; page 28, Cape Cod Canal, 2,791,846 tons; page 29, Intracoastal Waterway, Calcasieu River to Sabine River, 2,456,823 tons; page 29, Sabine-Neches Canal, 16,472,644 tons; page 29 again, Channel from Arkansas Pass

to Corpus Christi, 4,163,455 tons; page 29, St. Mary's Falls Canal, 42,248,131 tons; page 29, Detroit River Michigan, 30,469,121 tons; page 30, Lake Washington Ship Canal, 1,466,181 tons, which items total 116,261,767 tons, and I ask you whether it is not true that practically all of the traffic listed for these rivers and canals is deep draft vessel traffic, either Great Lakes or Ocean?

A. Well, the engineers of the TVA during the recess checked it over and stated that the figures were correct as put in your question."

[fol. 1001] All the figures on that list are for deep waterways, as far as the question is concerned.

The total, shown on page 30 of the report of the Chief of Engineers for 1930 as 215,146,078 tons, corresponds to my chart, Defendants' Exhibit 30, for 1934; but may I explain?

"Q. There is no explanation to make.

A. Yes, there is a very important explanation and that is this, if we assume that this chart here does not include, or eliminates duplication.

Q. It is not for that purpose. I am not asking you about that.

A. That is what it amounts to. Or if these are in error, you see, then plotting them so as to eliminate duplications as indicated in there, the rate between 1932 and 1934 would be practically the same as indicated on this chart. Now, the important question at issue in this right now is what would be my estimates for 1950, so that whether this includes the elimination of duplications or whether it does not, it does not change my estimate that by 1950 we will have recovered, so that my estimates for that are correct.

Q. All right.

A. So it does not affect—

Judge Allen: That is clear.

Q. That has nothing to do with the question that I want to ask.

A. It does not affect one iota my estimate of prospects or prospective commerce.

Q. Let me ask my question now, Colonel.

A. All right.

Q. How is it possible to make an analysis of the inland barge waterway traffic on the Tennessee River based on

exhibit 30 showing a total tonnage figure in which well over 50 per cent is found to consist of lake or ocean going traffic, which has no relation to barge traffic on our interior rivers.

A. I have charts which show the nature of the commerce on the Great Lakes. On all of them it consisted primarily [fol. 1002] in the first place, in the order of priority, iron ore, next in order is coal, the next item in priority, I believe was sand and gravel. The next item in the priority list was, I think, petroleum or forest products, the next item grain; all of those are various items that go into industrial development. Now my estimate that we will have this commerce on the Tennessee River is that the waterway will be a very efficient means of providing cheap transportation and that it would carry those various items of commerce needed for industrial development.

Q. That is your estimate was based on the assumption or belief that the navigation route on the Tennessee, and conditions were similar to the Great Lakes?

A. In other words, I looked at the character of the freight.

Q. Will you answer my question? 'Yes', is that the answer?

A. Yes, somewhat, because it differs between the Great Lakes and the Mississippi River System and the other rivers you were talking about. If you investigate those commences, you see that they vary somewhat in classes, yet they are all just about what it would be."

In my investigation I did not notice that in 1929 the commerce in iron ore through the Soo Canal was over 90,000,000 tons, and I do not know that the reason that commerce moved on the Great Lakes is because there is the greatest iron ore field in the world at the upper end of Lake Superior, and to some extent on Lake Michigan, and that it moves down to the steel districts in the coal fields at the bottom of the lakes. I do not quite agree with the way the thing is expressed. I do know that we have those important iron ore fields up in the Superior region, and that we have the coal in the Appalachian region. I do know that there is an enormous movement both ways for our industrial development. I think it is a wonderful illustration of what the Tennessee waterway may do in bringing together its iron ore and its coal, or bringing together its clays and its coal, or bringing together all of those various items which go to make up industrial development.

[fol. 1003] I am aware that there is no coal in Wisconsin, Michigan, Minnesota, and that that coal is shipped in largely from the southeast and from Illinois. There is coal in Tennessee and also in Illinois; but it is not all right with the iron ore, and not all with these other minerals. There is a separation in a great many places, and this waterway being within 10 miles practically of all the minerals in the basin will unquestionably be utilized for that purpose.

I am still of the same opinion as to the value of this water power as expressed in House Document 328 (Complainants' Exhibit 105) at Page 75:

"Summary of benefits to power by regulation of flood flow. A summary of benefits to power secured by regulation of flood flow is shown in Table C, pages 76 and 77, for each project on the main stream. The increase in output due to increase in normal effective head and regulation of flood flow for all projects on the Tennessee River amounts to an average annual of 121,390 kilowatt-years. The elimination of submergence of projects amounts to a saving of 764,100 kilowatts auxiliary steam installations. Valued at steam prices, these benefits amount to a total of approximately \$10,000,000 per annum. In an interconnected system consisting of a large number of hydro-electric projects, it is possible that a large portion of auxiliary steam installations required to supply power during periods of submergence may be eliminated by power supplied by other hydro projects."

"Q. You stated that it has these values and among other things benefits of approximately \$10,000,000 per annum, and I asked you whether you are still of the opinion that it has benefits of that order.

A. No, I cannot answer it yes or no, but I can say that I am aware that such statements are in this report, and I do think that the Court ought to know that a great part of this is brought about by the surcharge pondage on these high dams. That was the items you were reading, was it not?

[fol. 1004] Q. Well, I read that paragraph right before you.

A. Now, I think it is well for the Court to know that in making this survey the use of the surcharge pondage on all of these high dams was decided upon as a flood control measure before I realized the benefits that it would be to

navigation and to power, so that although it is a great benefit to power and to navigation, which is a great thing, yet there is no question whatever of the fact that this is primarily a flood control measure."

The main river dams in the TVA plan certainly have tremendous value for power purposes, and it is one of those resources of the waterway which we should conserve, unquestionably, for our industrial development.

"Q. What in your opinion would be the value of these tributary reservoirs for power purposes?

A. Let's express it this way, which I am sure is a correct way. The reservoirs on the tributaries are essential for flood control and regulation of stream flow. That is what they are there for.

Q. You have said that, and I asked you——

A. That is essential for the development of the resources of the waterway and I think it is a fortunate thing that it is of benefit for power, and that we may develop it. But I do not think that on account of that fact we can say that they are primarily for power, for they are primarily for flood control. It is flood control which brings about these benefits.

Mr. R. T. Jackson: I move to strike out the answer. It is not responsive to my question.

Mr. Fly: I think it is a proper explanation.

Judge Allen: It may stand.

Mr. R. T. Jackson: May an exception be noted?

Q. Now Colonel, will you answer my question? What, in your opinion, if you have any opinion, is the value of these tributary reservoirs for power purposes?

A. I think I said already, if I didn't, I will say, that they are very valuable, and it is fortunate that it is, because it helps to develop those resources."

[fol. 1005] I do not know exactly whether the table marked "Schedule 2, page 2" in the first deficiency appropriation bill hearings for 1936, page 279, in which Mr. Lilienthal shows that 660,000 kilowatts of continuous power could be developed, is reasonable. And I do not know exactly whether the statement that there would be a production of 5,780,000,000 kilowatt hours of firm energy annually is reasonable. The TVA engineers can give that information. I

do not know exactly how much storage would be necessary in order to provide 660,000 kilowatts of firm continuous 24-hour power and 5,780,000,000 kilowatt hours of firm energy annually in an extreme low-water year. The TVA engineers can give you that information. As I recall, the development of the reservoirs on major tributaries above Chattanooga would bring about effects perhaps greater than that. I am not sure. I do not know exactly.

I can tell approximately according to the general operations that the TVA tributary reservoirs would gradually rise, collecting the flood storage during the major flood period, and that they will vary from year to year. One year it will be more rapid than the other. Beyond that I am not prepared to give any figures as to what the elevations of those tributary reservoirs would be on Jan. 1, Feb. 1, March 1, April 1 and May 1, in order to produce such quantities of power under the TVA Unified Plan in a dry year. I am sure the TVA can give you a very good answer. In some years it will fill up more quickly than others because there is more water. Any good engineer can know how to handle the situation. I made surveys of them for the TVA report.

[fol. 1006] Examination by the Court:

It is a method of just practical common sense operation.

Cross-examination continued:

“Q. Well, it is a question of physical necessity in producing a certain definite amount of power, isn't it, Colonel?

A. It is essential for collecting flood waters which would otherwise go down into the main stream of the Tennessee River, and into the Ohio, and into the Mississippi during the periods of major flood. That is where it is all caught.

Q. And you must have at the beginning of your low water season enough storage to provide water that will produce this firm power, is that right?

A. No, that is not the purpose. The purpose is to catch these flood waters during the major flood season. That is the fundamental plan of this system.

Q. My question, Colonel, is this, not your purpose, if you are going to have a certain quantity of firm power produced by these projects it is necessary that you should have for low water years a certain definite amount of storage at the be-

ginning of the low water season which can be used to regulate the flow and augment the power production during that low water season, is that right?

A. That is not exactly correctly stated. It is necessary to catch as much of the flood water which would otherwise go down into the river during those floods as you can, and that will vary from year to year. I don't know exactly the stage in which the reservoir must be on June 1st. Some years in my plan it was not full at that date, but I don't believe that they have enough storage right now, and I do think they will have to fill it to whatever they figure is a safe place every year.

Q. In order to get the power?

A. Yes.

Q. That is right?

[fol. 1007] A. Now remember, you said for power during low flow. This is a great benefit for navigation also, all the way down the Tennessee River, and all down the Mississippi. Remember that."

(The witness was excused.)

(Counsel for defendants then read the following comment of the Chief of Engineers in House Document 328 at Page 7:)

"It leaves the project in the air by making navigation dependent on power development, and requires that the matter of the project be referred to Congress continuously. The project should be definite and final, and it is possible to make it so in this case, if ever, because there has never been presented to Congress a more thorough and exhaustive study. Lytle Brown, Major General, Chief of Engineers."

[fol. 1008] GEORGE R. CLEMENS was called as a witness on behalf of the defendants and, having first been duly sworn, was examined and testified as follows:

Direct examination:

I am 37 years old. My residence is Vicksburg, Mississippi. I am a Civil Engineer by profession and Senior Engineer, Hydraulic Staff, Mississippi River Commission. I was graduated in civil engineering from the University of

Michigan. Following this I spent about 5 years in miscellaneous engineering jobs, including surveys, drafting construction, design of buildings, design of highways, and teaching in an Engineering College, namely, Wayne University, Detroit. At the conclusion of this 5 years of preliminary experience, I entered the service of the U. S. Engineers Department at Buffalo, New York. In this office I worked on the report, preparing hydraulic studies, and studies of probable commerce for waterways from the Great Lakes to the Hudson River. At the completion of this work, I went to the U. S. Lakes Survey Office in Detroit and made various hydraulic studies on the proposed St. Lawrence Waterway. On completion of this assignment, I returned to Buffalo and worked on a review of the aforementioned study of a waterway from the Great Lakes to the Hudson River. I had one or two short jobs following this and in June 1927, I went to the office of the Chief of Engineers for work with the Reservoir Board, studying the Mississippi Flood Control Project. I worked with this Board in Washington for the next year. On completion of this work, I was transferred to the office of the District Engineer of Vicksburg, Mississippi. In this office I spent $3\frac{1}{2}$ years in charge of the so-called 308 studies. I went there in June 1928.

On the Red, Ouachita and Yazoo Rivers, I was charged with the preparation of the reports on these streams, involving studies of flood control, navigation, water power and [fol. 1009] irrigation. I prepared the preliminary and project reports on the Yazoo project, which were later used in the plan finally adopted by Congress for the Yazoo system. This same period included various studies of hydraulic problems on the Mississippi River.

Late in 1931, I was transferred to the office of the President of the Mississippi River Commission. In this office I was charged with the preparation of the so-called Comprehensive Reservoir Report. In addition to this report, I was in charge of the hydraulic and dredging section in the Commission office. On the completion of that report, I have continued in charge of the hydraulic and dredging section, engaged in many and miscellaneous studies of the flood control and navigation problems on the Mississippi River. This was continued to the present time.

I neglected to mention in my education that I received, twelve years after I graduated, the graduate degree of Civil

Engineer from the University of Michigan, my thesis for that graduate degree being "The Reservoir as a Flood Control Structure." I am a member of the American Society of Civil Engineers, past president of the Mid-West Section, American Society of Civil Engineers. I am also a registered Engineer in the State of Michigan and a member of various other local engineering societies.

The Mississippi River Commission is a body created by an Act of Congress in 1879 charged with the flood control and navigation project, preparation of plans and studies on the Mississippi River. The Mississippi River is the father of waters of the United States and contains 1,250,000 square miles of drainage area or thereabouts. It is formed by a number of major tributaries. The Missouri and the upper [fol. 1009-a] Mississippi, so-called, join at a point a short distance above St. Louis and continue from St. Louis to Cairo through what is called the Middle Mississippi. At Cairo it is joined by the Ohio, which a short distance above its mouth is joined by the Tennessee and the Cumberland. Proceeding on downstream through what is called the Lower Mississippi, the river is joined from the west by the Arkansas, a short distance above Arkansas City. On down-[fol. 1010] stream, above Vicksburg, it is joined by the Yazoo from the east and near Angola it is joined by the Red River. The major tributaries are as I have noted. The length of the river from Cairo to the Gulf is about 970 miles.

The lower Ohio is somewhat different from the Mississippi. The Mississippi is alluvial from Cairo down. Perhaps for a short distance east the Ohio is alluvial. The Cumberland and Tennessee join the Ohio. The Tennessee, about 40 miles above Cairo, is sometimes referred to almost as an independent tributary, it comes in so close to the mouth of the Ohio. Cairo is at the junction of the so-called Middle Mississippi and the Ohio and is about 40 miles downstream on the Ohio from the mouth of the Tennessee.

As regards floods, the most serious problems of the Mississippi Basin are from Cairo to the Gulf. Below Cairo is a wide alluvial plain which must carry in the valley the flow of the Ohio, the Mississippi and the Missouri from above. As we pass down, it must be able to add the flow of the Arkansas, the Yazoo and the Red. The valley ranges in width from 40 to 80 miles, all subject to overflow at some

time. It is a highly developed area in many places and undoubtedly the richest farm lands in the United States.

The Mississippi Flood Control Project is the oldest that we have in the United States. It is outstanding also and it is the greatest flood control project that we have. It has been a very gradual development. The development of the project started with the first settlers. Our first levees were built at the time the first settlers hit New Orleans, about 1717. There has been progressive development of the flood project since that date. As to the progress and development of the valley, I might add the protection of the valley has contributed from 52 to 90% over that range in these of protection afforded.

[fol. 1011] There were floods, of course, prior to 1900, but I will name the great floods of record since 1900 which have done serious damage to the alluvial valley. From 1900 to date, there have been the floods of 1903, 1907,—1907 was not very big—1912, 1913, 1916, 1922, 1927, 1929 and 1937. In the upper river the 1937 flood was the most serious. In the lower river the 1927 flood. The next to that, it is a question of 1912 or 1916, say 1912 to get a figure. 1916 was about the same.

The principal contributor to the lower Mississippi floods is, of course, the Ohio. The past floods have ranged from about 52 to 90% of the contribution of the flow at Cairo. Of the total flow in the Mississippi River below Cairo, the Ohio has contributed from 52 to 90% over that range in these various floods. The remainder comes from the upper Mississippi and the Missouri, varying with each flood. Proceeding on downstream, the next major contributor is the Arkansas and the White, which I neglected to mention in my previous statement. It might be construed a separate tributary or a portion of the Arkansas. It joins the Mississippi partly through the Arkansas and partly through a mouth of its own, but the Arkansas and White together are heavy contributors in certain floods. The Yazoo never put out very much, and the Red only moderate amounts.

In referring to the Ohio, I consider the entire Ohio Basin. In stating how the effect of the contribution of the Ohio is transmitted downstream and the extent of the transmission, I will say that the two flows combine at Cairo and there is relatively little addition between Cairo and Helena. At Helena the St. Francis enters and brings in a small per-

centage and about the mouth of the Arkansas—let us say the [fol. 1012] percentage of the flood contribution is approximately the same as it is at Cairo. Below the Arkansas, in our major floods, take our project floods for instance, we get somewhat over two-thirds—let us say 70% of the flood from the upper river. Roughly, the flood from the upper river is $2\frac{1}{4}$ million second feet and from the Arkansas is enough to make it slightly over three million. I believe the percentage is approximately that.

In describing the projects that have been undertaken for control of these floods, I will not go into ancient history and take each project from 1717 to date, although there have been many as the valley and the projects developed progressively. At the time the 1928 plan was developed, the valley had just experienced a disastrous flood which had broken levees in many places, caused considerable damage and loss of quite a number of lives and disrupted generally the business throughout the entire Mississippi Valley. There was a widespread demand for increased protection to the Mississippi Valley following this flood, which resulted in the so-called Jadwin Plan, adopted by Congress by Act of May 15, 1928.

The Jadwin Plan combined a system of levees and floodways which I can describe briefly from the map (offered and received in evidence as Defendants' Exhibit 31) of the alluvial valley of the Mississippi River.

The plan described by this map (Defendants' Exhibit 31) is the Jadwin Plan. We have shown the alluvial valley of the Mississippi River from Cairo to the Gulf, and there is indicated thereon the so-called Jadwin Plan for Mississippi Flood Control, which was adopted by the Act of May 15, 1928. The basic feature of the Plan was the enlargement of [fol. 1012a] the existing system of levees extending from Cairo all the way through to the Gulf. There are certain areas that are without levees and are not protected by [fol. 1013] this Plan. In general they are small, although in the case of two backwater areas, namely, that of the Arkansas-White and that of the Yazoo and the third one at the mouth of the Red River, they involve considerable areas.

On the right or west bank of the river, there is a levee that continues, except for a break at New Madrid, from Commerce, above Cairo to Helena, some distance below Memphis. This levee in general protects the so-called St.

Francis basin, being the area to the west of the river extending from a line through Commerce and Cairo to approximately the latitude of Helena. At Helena the St. Francis River joins the Mississippi and there is a moderate backwater area flooded in that vicinity. Below Helena the levee continues on the west bank to the vicinity of Laconia Circle, where there is again a gap in the levee system at the mouth of the Arkansas-White Rivers. Continuing on down the west bank of the river, the levee begins at Pine Bluff, up the Arkansas, to the mouth, follows the Arkansas to the Mississippi, then down the Mississippi a continuous levee to the mouth of the Red, protecting the so-called Tensas basin to the west of the river. Back upstream to Memphis, there is a levee on the left or east bank of the river that is continuous from Memphis to a short distance above Vicksburg, protecting the Yazoo basin. Below the mouth of the Red River, there is a levee on the right bank of the river which is continuous to near the mouth of the river, some distance below New Orleans. On the left or east bank of the river there is no levee from the mouth of the Red to approximately Baton Rouge, at which point the levee begins and continues on down to Pointe a la Floche outlet, some distance below New Orleans. There is also a system of levees down the Atchafalaya River, one on either bank of the river, which river is an additional outlet to the Mississippi water, reaching it through a short connecting link termed Old River where it joins the Red [fol. 1014] River and thence proceeds towards the Gulf through the Atchafalaya basin.

The lower river is termed the Atchafalaya basin. The basin on the west side of the river from the Arkansas to the Red is called the Tensas basin. The basin on the east side of the river from Memphis to Vicksburg is called the Yazoo basin, and the basin from Cairo to the Arkansas on the west side of the river the St. Francis basin.

These levees were in existence prior to 1927 and in generally the same position. The Act of 1928 provided for a general raising and strengthening of this levee system. In addition it was considered that provision should be made for a greater flood than could be contained within the levee system. The first supplementary work was that in the vicinity of Cairo, termed the Birds Point-New Madrid floodway. The flow of the Ohio and Mississippi Rivers is forced into

a rather narrow outlet at Cairo and Wickliffe, and without some relief at that point, as for a flood such as it was supposed to control, would reach a height in excess of the raised levee. The floodway consists of a so-called set-back of the old front line levee, providing an enlargement of the flow area at that point, which by reason of creating a greater discharge capacity for a given stage results in a reduced stage at Cairo for the project flow. Below the New Madrid floodway, it was feasible to raise the levee sufficiently to contain the project flood, down to the mouth of the Arkansas.

From the experience in the 1927 flood, it was obvious that the Arkansas-White rivers together would pour out a tremendous volume of water that would be in excess of any reasonable raising of the levee system below that point. Therefore, under the Jadwin Plan it was proposed to leave the levee from some distance above Arkansas City to some point in the vicinity of Luna Landing at its existing grade, [fol. 1015] without raising the grade of this levee, so that in great floods in excess of the channel capacity, the water would not break out of the levee system at any point in this reach, but would break out over this low levee. Then to prevent the water that left the main river at that point from spreading out over the entire Tensas basin, the so-called Boeuf Protection levees were provided. These levees are shown by orange lines on the map, the westerly line extending from a point above Arkansas City to a point a short distance above Monroe, Louisiana, the easterly line more or less paralleling it, but extending on down stream to a point northeast of Harrisonburg. In addition a ring levee was to be provided for the protection of the City of Monroe, Louisiana.

Thus for the reach from the Arkansas to the Red there was provided an emergency area through which great floods might pass in the event they exceeded the capacity of the enlarged levee system. Below the mouth of the Red River, the combined capacity of the Atchafalaya River and the Mississippi River was insufficient to accommodate the flow of the project flood. It was therefore decided to include in the project similar relief overflow areas to permit the passage of great floods to the Gulf, over sections of levee which would not be raised as the remainder of the levee system.

On the eastern side of the Atchafalaya River, the levee from the head of the river to a point near Morganza was to be left at its existing grade, and with the balance of the levee system raised, a great flood would flow over that levee, thence down through the Atchafalaya basin, and be restricted to an area by a protection levee which would be called the East Atchafalaya Floodway levee. Similarly, on the west side of the Atchafalaya basin, or the Atchafalaya [fol. 1016] river, the levee from the head of the river for several miles was to be left at existing grade, and a protection levee provided along the western limit of an area to limit the overflow in the Atchafalaya basin. About half the flow was considered as passing through the combined Atchafalaya River and the two relief outlets, or floodways as they are frequently called. That left about half of the project flood to go on down the Mississippi River past New Orleans. Even this flow was too great for the city of New Orleans, so that a spillway with gates to be controlled in time of great floods was provided at Bonnet Carre, which would take the flow from the river above the city of New Orleans, dump it into Lake Pontchartrain, and thence flow on out to the Gulf, reducing the probable flood heights that would be obtained at New Orleans in the event of a great flood.

Thus we have throughout the river a system of levees, and a system of relief or emergency outlets or floodways at critical points to take care of floods greater than those that might be accommodated within the levee system. The major portion of the valley is protected from great floods, certain areas, however, being found not feasible to be protected, one of those extending along the east banks of the river from Cairo to Memphis, with the exception of a short section between Hickman and Tiptonville, Tennessee, which is protected by a levee connecting at high ground at Hickman and at Tiptonville. It was not feasible to protect this area because the area is so narrow there that the high levee that would be required would not be justified by the area that would be behind the levee. However, there has been some extension of this levee where there is a wider area between Tiptonville and Ridgely, Tennessee. Similarly, below Vicksburg, extending on down to Baton Rouge there is a narrow area along the east bank of the river. Then, at [fol. 1017] the mouths of the principal tributaries there are

areas that are subject to backwater overflow, the principal ones being that at the mouth of the St. Francis, above Helena, the mouth of the Arkansas-White, above Arkansas City, that at the mouth of the Yazoo above Vicksburg, that at the mouth of the Red above Angola. Then, there will be flooded in times of extreme floods an area within the floodways, that is the Birds Point-New Madrid floodway, between the river levee and the floodway levee, the area in the so-called Boeuf floodway, and the area in the so-called Atchafalaya floodway.

To get some idea of the relative size of the protected areas, and the overflowed areas, this map has shown on it in a blue cross-hatched overprint the area flooded by backwater in the 1929 flood. That is not the major flood of record. It is a relatively high flood, and was entirely confined by levees, but by noting the extent of the blue cross-hatched area in these unprotected areas, and in the backwater areas you get some idea of the relative size of those areas.

With reference to the way the floodways operate, the project assumed, taking the floodways in order, first that the Birds Point-New Madrid floodway would have at its head a levee equivalent to 55 feet on the Cairo gauge. This involved cutting down the existing levee, and necessarily meant that the United States must purchase the right to permit this additional flooding over the land owners within the floodway. After that levee is cut down, this floodway would function by the water merely coming up to the top of the levee and overflowing. Actually in 1937 we had a little different situation, due to the fact we had not acquired all of those rights. In the Boeuf floodway the situation is still [fol. 1017a] different in that this was merely assumed as an emergency outlet to take care of floods greater than those that we have had in the past, and the levee was not to be disturbed, it was to be left at its height as it existed [fol. 1018] at the time of the passage of the 1928 Act. Similarly at the head of the Atchafalaya basin the levee was to be left at its height at the time of the passage of the Act, and the water entered the floodway by merely overflowing the levee. There have been modifications which I will come to in a moment. This is still a different system at Bonnet Carre, where the flow into the floodway actually is controlled by gates.

After a rather comprehensive study of the possibilities of various floods, it was decided that a reasonable flood

to take for the project flood at Cairo would be one equivalent to a flow of about two million and a quarter second feet. Carrying this two million and a quarter second feet on down to the Arkansas, and assuming that it was met by a flood equal to that of 1927 out of the Arkansas, there would result a flow of somewhat over three million second feet below the Arkansas. Proceeding from the Arkansas to the Red, the contribution of the Red River about compensates for the storage effect in this region and the flood below the Red River was still considered at 3,000,000 second feet, of which one million and a half would go down the Atchafalaya River and floodways, and a million and a half down the main river, with 250,000 out at Bonnet Carre.

Examination by the Court:

We have a crew of men who are measuring the flow of the river at certain critical points all the time. That is, they measure twice a week and during flood times they measure every day and determine the velocity and depth and from [fol. 1019] that compute the number of cubic feet per second that go by a definite point.

Direct examination continued:

As to what safety factor was allowed, the Levee Board assumed a one foot free-board on the levees on this adopted plan. In my opinion it is not safe to have less than this amount of free-board. I would prefer more. I would not want any less. One foot free-board means the top of the levee would be one foot above the calculated flow line of the flood.

There have been a number of modifications and changes in the plan for Mississippi flood control since its adoption. The people residing within the so-called Boeuf and Atchafalaya floodways objected very strenuously to these floodways and sought to enjoin the United States from constructing the floodway levees, and a great deal of litigation resulted. Studies of other possibilities were continued as the main features of the plan were being constructed. A modification of the Jadwin Plan was adopted by Congress in 1936, called the Markham Plan. I have it shown on the small sheet attached to the map. I might just now note a few of the features if I might. In answer to the question as to whether it was the act of June 3, 1936 that I referred

to, I will say that there were two Acts in June 1936. I forget the dates. There was a general flood control act called the Omnibus Bill and this other Mississippi Flood Control Act.

The major change below the Arkansas was the substitution of the so-called Eudora floodway for the Boeuf flood-[fol. 1019a] way. The Eudora floodway differed in a number of respects. It was assumed that the outlets into the Eudora floodway would be controlled in some manner. I do not mean by that that there would be gates but there would be some kind of structures to permit the flow into the floodway rather than merely to flow over the top of the levee. The United States then would acquire flowage rights over the lands in the floodway, whereas under the theory that they were not lowering the levees into the basin, they did not seek to acquire rights in the Boeuf floodway. Topographically the Eudora floodway is lying east of the Macon Ridge, the Macon Ridge being the white area on the map, extending from Eudora through Delhi to Gilbert, placing the floodway down the valley of the Tensas and Macon Bayous.

However, the construction of this floodway was contingent on the United States securing options for the lands which Congress considered reasonable, a figure which was [fol. 1020] written into the Act, as I recall. They stated that 75 per cent of the options must be secured before the construction would proceed. That has not been done, although the securing of the options is under way. Similarly, in the Atchafalaya basin it was proposed to secure flowage rights over the west Atchafalaya floodway, and alter the head of the east Atchafalaya floodway to exclude a considerable developed area from the head of the Atchafalaya floodway opposite Angola down to the latitude of Morganza, bringing the west levee of the east floodway down stream to Morganza rather than at the head of the basin. Those were the two major floodway changes. In addition, an outlet was provided from the lower end of the Atchafalaya basin to be constructed at some point west of Morgan City. That has since been placed under construction in the vicinity of Wax Lake, that is a supplementary outlet to the Atchafalaya River. The Atchafalaya River at present flows out through a channel to the Gulf at Morgan City. In the modification of the Act, it was considered that this

outlet was insufficient and an additional outlet provided at Wax Lake. In addition to these changes, provision for improvement of the channels from the Arkansas to Angola and the approval of the outlet channel of the Atchafalaya was provided. There are two other major features I would like to mention. It was found that in addition to the flooding of the Yazoo basin from the main Mississippi River, there was also danger of flooding the Yazoo from the tributaries. So that the modified Act provided approximately \$50,000,000 for a tributary protection system on the Yazoo tributaries, to alleviate the flood damage from local tributaries. That was a system of seven reservoirs that was provided. On the St. Francis system, a similar tributary protection system was provided, as this area in the St. Francis basin west of the main levee is also overflowed by floods coming down from the headwaters of the St. Francis. [fol. 1021] This system was either to be a reservoir and levees, or all levees, and the present plans are for a combined reservoir and levee for protection from the tributary floods of the St. Francis basin. The last item was a provision for the so-called emergency reservoir at the mouth of the White River, consisting of a levee extending up the White River from the Mississippi that would be breached in times of great floods to provide some storage for flood peaks at the mouth of the Arkansas.

The project levee height at Cairo is 60 feet on the gauge. The gauge at Cairo in the 1937 flood peak was 59.51. At this gauge height, the flow at Cairo was a little over two million cubic feet per second. I believe our measure was 2,010,000 cubic feet per second at a point below Cairo, on the Mississippi River. There was an unusual situation developed at Cairo, as has been brought out. The flood originated largely in the Ohio basin and produced a slope up the Ohio River that was steeper than had been experienced before. This resulted in a small amount of overtopping of the Cairo wall and Cairo Drainage District Levee at the upper end of the Cairo wall. This amounted to approximately 8 or 9 inches and the flood was as much as a foot over the top of the levee. This was not permitted to enter the City of Cairo by emergency sandbags above Cairo. The Cairo Drainage District was protected as well as Cairo from this flood. Those measures are good flood fighting measures, but I would not want to depend on them as permanent measures.

This result happened at Cairo at a time when the peak flow was 2,010,000 cubic feet per second. There are two things involved in answering the question whether or not the existing levee is adequate for the two and a quarter million feet assumed under the previous plan at Cairo and in the question as to what is my opinion as to the maximum [fol. 1022] probable flood for which protection should be provided at Cairo. I might explain that there were several factors which affected that. In the first place, the New Madrid floodway was not completed to the extent of lowering that levee at the head of the floodway and it was necessary to resort to artificial opening of the floodway. This was successful in that in connection with the bulkheading at Cairo it prevented overflow of Cairo, but did result in a somewhat higher stage at Cairo than in my opinion would obtain if the floodway levee had been cut down and the water permitted to go into it at a lower stage. There has also been some deterioration of the channel in the reach from Cairo to New Madrid which further increased the flood stage at Cairo for a given flow, and the combination of these two factors resulted in that apparent discrepancy between the 2,000,000 and 2,250,000 second feet.

As to what flow I think should be provided for at Cairo in the light of the 1937 flood, I think it reasonable that the 2,250,000 should be increased somewhat. I believe the flow perhaps proposed by the Chief of Engineers of 2,600,000 to be a reasonable figure to consider for Cairo. In the event of that super-flood as now estimated, we would have a big high-water fight on our hands at Cairo, but I am afraid that is a little too much. Probably it would go over the top of the levees if we got 2,600,000 tomorrow. If it will wait just a little while, we will have something fixed up there to take care of it.

I spent the 1937 flood in Cairo and my opinion is I don't want to see those levees any higher. Perhaps you could argue physically it is possible to build them higher but I don't believe we should enter into any project of that sort. My own opinion is the levee should not be raised, but I think all possible means of lowering flood heights should be carried out.

[fol. 1023] Reservoirs for the purpose of controlling the Mississippi floods have been studied a great many times. The Act of May 15, 1928, which adopted the Jadwin Plan, also provided for a comprehensive study of reservoirs

throughout the Mississippi basin and provided that a report on a comprehensive reservoir system be submitted to Congress after the subject had been thoroughly investigated.

"Q. Now, will you describe the character and the extent of that investigation as to the feasibility of flood control reservoirs, and your own participation and responsibility in that work.

Mr. R. T. Jackson: I object to that question; the investigation and report on it is an official report made to Congress by responsible engineers, and by 'Responsible' I mean officially responsible, in behalf of the Army, and it was not under this gentleman's direction.

Judge Allen: The objection is overruled. He may answer.

Mr. R. T. Jackson: May we have our exception, please, particularly as to anything that goes beyond what he personally did?"

I was transferred to the Mississippi River Commission's office from the Vicksburg district in 1931 specifically to take charge of the preparation of this report. The data for this report was to be furnished by the various district officers, charged with the direction of the work on the different tributaries to the Mississippi. We prepared a comprehensive set of instructions regarding the study of reservoir possibilities, and the submission of various data to permit our own studies of combining those data to determine the effect of the different tributary systems on the Mississippi River. The studies made under my supervision were those of computing the effect on the Mississippi River of these various systems of reservoirs studied by the district officers. Generally speaking, we had the districts submit two plans. There were others. There were two that we considered most important. First was that involving the selection of reservoirs [fol. 1024] on each tributary that might be operated in the interest of Mississippi River flood control. Second, reservoirs on each tributary operated in the interest of local flood control.

We combined the first group of reservoirs into a general group which we referred to as Plan 1 in the report, and computed the combined effect of this group of reservoirs on the Mississippi River. The report shows the reduction in figures that might be obtained at key points along the river. Similarly, we took the second group, termed Plan 2, and

combined the effect of these on Mississippi River stages and found the incidental effect on Mississippi River flood control that might be obtained by this second group. The results of these studies were combined into a report submitted by the Mississippi River Commission to the Chief of Engineers, printed as House Document 259—I forget the rest of it. I personally prepared the drafts of the report, directed the studies and presented the report to the Commission for their consideration and approval.

“Q. And the Commission approved the report and forwarded it to the Chief of Engineers?”

Mr. R. T. Jackson: I object to that. The report speaks for itself.

Judge Allen: The report does speak for itself, but how does it hurt you to have this witness answer, if you don't contest the fact it was approved. Do you contest the fact it was approved?

Mr. R. T. Jackson: The Commission made a report and recommended certain things, and did not recommend certain things that this witness has been telling about. The general implication that would come from his statement that they approved it would be that they had taken some different course.

Judge Allen: Is the report in evidence?

Mr. R. T. Jackson: It is not.

Mr. Fly: It will be offered, your Honor.

[fol. 1025] Judge Allen: The objection is overruled.

Mr. R. T. Jackson: We except.

Judge Allen: Just a minute, Mr. Reporter. The Court thinks that in the case of these technical witnesses, witnesses both on behalf of the Complainants and on behalf of the Authority, that we get light from their explanation. We don't think either that there is any prejudice to either side in a statement of this kind which we have permitted to be made on behalf of each litigant. We don't think that the technical objections which are applicable to other sorts of testimony should be drastically enforced with reference to expert testimony of this kind, no prejudice appearing.

Mr. R. T. Jackson: If I might merely explain, I don't make the objection as a technical objection, but because I do not wish to have either to cross examine or argue about whether or not the statement of this witness is in accord

with the record which will appear from the document itself, and which must be controlling."

The Commission approved the Report and forwarded it to the Chief of Engineers. There has been so much discussion and misunderstanding of this recommendation and interpretation of the word "recommendation" that I would like to read the exact wording of that recommendation before stating what specific systems of reservoirs were recommended for the control of Mississippi floods.

The document (offered and received in evidence as Defendants' Exhibit 32) is a copy of the Mississippi River Commission Report in House Document 259, 74th Congress, 1st Session. (Thereupon the witness read from paragraph 81, page 33.)

This report recommends that a general policy encouraging the participating in the construction of feasible tributary systems be adopted, and outlined Plan 2 as that general system. You will find Plan 2 reservoirs listed beginning on page 44 and extending through page 49. The total for the entire system was some 98,000,000 acre feet and a billion and a quarter dollars. That plan included various reservoirs on the Tennessee system set forth on page 46. The Commission recommended a total volume of storage of 10,188,100 acre feet on the Tennessee system. The reservoirs in Plan 1 were selected from those that would give the maximum reduction for Mississippi River flood control and those in Plan 2 were those that would give maximum reduction for local flood control with incidental Mississippi River flood control.

"Q. In your opinion, what reservoir sites on the Ohio River system are most effective for Mississippi River flood control?

Mr. R. T. Jackson: I object to that question because we are going into a wide field in the Ohio.

Mr. Fly: I don't think so, your Honor. The witness will say that the Tennessee is.

Mr. R. T. Jackson: If that is true—

Judge Allen: Overruled. He may answer.

Mr. R. T. Jackson: May I state, your Honor, the ground of my objection? The mere fact the witness is willing to

state the Tennessee does not exclude the scope of the inquiry from the whole Ohio River system. Obviously if he is entitled to select that, we are entitled to explore the whole Ohio River system.

Judge Allen: He may answer.

Mr. R. T. Jackson: Exception noted, please.

A. The lower tributaries of the Ohio would be the best. Those reservoirs within prediction distance, including of course the Tennessee; other lower tributaries are also valuable, the Cumberland, Green and Wabash."

About 40 per cent of the storage recommended for the Ohio system is on the Tennessee. In the floods on the lower Mississippi, it is important to avoid the use of the floodways whenever it is possible to do that without jeopardizing the rest of the valley. The present height of the main levee about the entrance of the Birds Point-New Madrid floodway is about $57\frac{1}{2}$ feet on the gauge height. The flood waters were diverted into the Birds Point-New Madrid floodway in the 1937 flood at about that height on the main levee. [fol. 1027] However, the main levees broke and the waters were diverted by natural crevasses in the main levee system. These natural crevasses were followed shortly by additional artificial crevasses to increase the flow. The gauge height at Cairo went up to 59.51 and the flow was 2,010,000 second feet in the 1937 flood. It was not at that height at the time of the initial crevass but it went up to 59.50. The contribution of the Tennessee River at the time of the crest at Cairo in 1937 was about 200,000 cubic feet per second, about 10 per cent. Assuming at least 150,000 cubic feet per second of the flood waters in the Tennessee could have been stored and retained on the Tennessee throughout the period of the crest, that undoubtedly would have been a substantial alleviation of the flood waters at Cairo and the entrance to the Birds Point-New Madrid floodway. Prior to the time when the crevasses opened and the flood waters entered the floodway, the retention of this 150,000 cubic feet per second would have effected a reduction of approximately 2 feet in gauge height.

Studying over those great floods on the Mississippi which I listed, the minimum contribution of the Tennessee was approximately 150,000 second feet at the crest of those floods. In a number of them it was larger. That is, as to the

minimum, the smallest we had. As I remember, one went up to 350,000.

"Q. Now, it appears from the records that there are at least 7,000,000 acre feet of controlled storage at the Gilbertsville, Pickwick, Guntersville, Norris and Hiwassee Dams.

Judge Allen: Is that the combined sum of them?

Mr. Fly: That is the total acre feet of controlled storage there, your Honor, yes.

Q. Will you state whether in your opinion such storage could have been operated in the 1937 flood to reduce the flow at Cairo during the 1937 flood by 150,000 cubic feet per second throughout the crest of the flood?

[fol. 1028] Mr. R. T. Jackson: I object to the question upon the ground that the assumption of it does not appear in the record.

Mr. Fitts: Complainants' Exhibit 15, the 1937 appropriations hearing, there is a table which sets out the controlled storage in all the dams. It is now in the record.

Judge Allen: Objection overruled.

Mr. R. T. Jackson: I think that includes in the first place a good many dams not included in this record, and in the second place it includes power storage.

Mr. Fly: It is denominated controlled storage in the tables which they, themselves, put in the record.

Judge Allen: Objection overruled.

Mr. R. T. Jackson: Exception.

A. With 7,000,000 acre feet available, from the study of flood hydrograph of this 1937 flood, I see no reason why it should not have been possible to store the 150,000 second feet from the crest of the 1937 flood."

Assuming that this 7,000,000 acre feet of storage in the dams which have been mentioned will be operated for Mississippi flood control, this will enable a substantial reduction in all major floods on the Mississippi at Cairo. In forming this opinion, I have made what I consider ample allowance for a safety factor.

In explaining the relative functions of the main stream and tributary dams for flood control purposes, the tributary dams provide seasonal storage and some additional storage

in case of great flood peaks. The main stream dams would be within prediction distance and could take off the water at the proper time and remove it from the flood crest at Cairo. They should be able to regulate any deficiencies that might occur from the tributary dams. I think it is very desirable to have a system which provides substantial storage both on the main stream of the Tennessee River and its tributaries, [fol. 1029] if it is determined that the contributions of the Tennessee to the Mississippi River floods are to be reduced or controlled. I can see no value in a series of low dams on the main stream of the Tennessee River such as that set forth in House Document 328 to control the high water on the Tennessee and aid Mississippi River flood conditions.

The construction of high navigation and flood control dams on the main stream of the Tennessee River displaces the so-called valley storage. In my opinion, the construction of the high navigation and flood control dams on the Tennessee River is of substantially greater aid to the Mississippi flood situation than the so-called valley storage. The so-called valley storage seems to have been here a confused issue. I think it might be that this term "valley storage" is a mysterious term used to give a very simple thing an unduly complicated definition. Valley storage is the space occupied progressively by the crest of a flood wave in its passage down the valley. The valley storage is the valley, and the flood peak in passing down the valley occupies progressively different positions in the valley and the accumulated effect of those positions is the valley storage. It is just the flood.

Examination by the Court:

It is the space occupied by the flood as it goes down the stream in its natural course throughout the valley. It is variable with each flood. That is, if we have a flood height of 10 feet, it occupies certain space as it passes progressively through the valley. If we have one of 20 feet above low water throughout the valley, it will occupy a much greater space. If we have one of 30 feet, it will be still greater. So it is of variable quantity, depending on the flood. When the [fol. 1030] river is at its natural stage, the land flooded by the river is valley storage. Then when the river is higher, it is still valley storage, more valley storage. In time of flood the waters spread out throughout the valley and are

to some extent retarded by that spreading out. It is not controlled but it is retarded or delayed in its passage through the valley. There is no valley storage unless there is a flood. The valley storage is entirely uncontrolled and the water goes out of the storage. There is no valley storage unless the river is out of its bank. A simple illustration of the effect of valley storage might help. In the 1937 flood, the Tennessee River crested ahead of the Ohio River at Cairo. As the flow of the Tennessee passed through the valley storage, it was retarded and the flood peak held back, which brought that peak back closer to the peak at Cairo. However, it was still eventually before the peak at Cairo and was falling at the time Cairo was rising to its crest. As it fell, it was drawing water out of the valley storage of the river and was actually placing valley storage on top of the flood crest at Cairo, so that the valley storage in the Tennessee, uncontrolled this year, increased the flood crest at Cairo.

Direct examination continued:

"Q. Now, Mr. Clemens, I want to ask you one of Mr. Jackson's questions:

Suppose you have a chain of dams which displaces 10,000,000 acre feet of valley storage, but provide 5,000,000 acre feet of flood control storage which cannot be increased by draw-down in advance of the flood. Would that chain of dams increase the flood height at the lower end of the chain of dams?

A. There are too many variables in that answer."

To take an extreme case and set out one of the variables, it is not stated what the flood is. Suppose the volume of the flood which you are going to pass through this new series of dams, which had filled up 10,000,000 acre feet of valley [fol. 1030a] storage, and have a volume of 5,000,000 acre feet, it is obvious that if you start to pass 5,000,000 acre [fol. 1031] feet of flood through a series of dams that has in addition to 10,000,000 acre feet of valley storage, 5,000,000 feet of available storage, you will not get anything through.

If we put in 20,000,000 acre feet, we could reduce that 20,000,000 acre feet of flood and make it a 15,000,000 acre foot of flood, as the height that that flood would reach.

But the height would depend upon the character of the flood wave. It would take about a month with a good corps of men to determine what that would be. I certainly would be able to extract that 5,000,000 acre feet, but it is purely an estimate as to the manner. You would need a hydrograph. I could get along without the rainfall if you gave me the run-off and where it came into the stream. I would have to know where the storage was. You would have to have the rate of flow each day during the flood, so you could take that rate of flow and route it through the successive basins to determine the rates of flow at the lower end. The question of time is in any flood study. We must have the volume and the time. You cannot merely take the volume as an abstract thing without relation to time. You have to have volume and time.

I want to know what the storage is, how much water may be stored in the system. I want to know how much water is in each pool and how much available storage space at each pool. I want to know the capacity of the flood gates at those dams. Assuming that I had all that information and any additional information that would be necessary and sufficient number of slide rules, a corps of assistants, I would want at least a month to give a satisfactory answer to that question of Mr. Jackson's.

[fol. 1032] I see no reason why the provision of a substantial amount of storage on the Tennessee could not be made to fit into any ultimate plan of reservoir flood control, such as that recommended by the Mississippi River Commission, letting it come back to the question of operation. It could be so operated. I cannot state how it could be done, but it could be physically possible to do it.

I see no reason why a suitable method of using the 1,500,000 acre feet of storage capacity in Norris Reservoir between elevations 995 and 1020 could not be worked out for flood control and at the same time to obtain large benefits for low water regulation from this same space.

I have read over Mr. Kurtz' testimony. I would need months of study to give you an exact effect of Mr. Kurtz' study, but I would consider that type of system a distinct hazard to the Mississippi River flood control. I would like to explain my answer this way, that that system of retarding flood flows would necessarily result in delaying the flood crest at the mouth of the Tennessee River. What we are

interested in on the Mississippi River is not so much the greatest floods that come out of the Tennessee, but these ordinary floods that come out of the Tennessee on top of the big Mississippi River floods. Normally those floods are out of the way of the main crest at Cairo. If you put in a system of retarding reservoirs, which delay the Tennessee crest by its proposed system of operation, it will increase the flood crest at Cairo, and I would be very much afraid of that.

If I was instructed to provide a 9-foot navigable channel upon the main stream of the Mississippi River and assist in the control of the flood waters of the Tennessee and Mississippi River valleys by means of dams on the Tennessee and its tributaries, I would construct dams similar to [fol. 1033] Norris on the tributaries and Pickwick, Wheeler and Gilbertsville on the main river. No other type of dams on the Tennessee and its tributaries would accomplish all of these purposes. You need that general type. I am not stating that that would be exactly the dams I would build, but that type of dam, both on the main river and the tributaries.

Cross-examination:

I referred in my testimony to Defendants' Exhibit 32, House Document 259. That is the exhibit in which there is set forth two general plans of reservoirs on tributaries of the Mississippi that have been studied. The total of the storage in those plans is something around 98,000,000 acre feet. The general character of my estimate was that if this entire reservoir system were constructed at a cost of something around a billion and a quarter dollars and operated primarily for the protection of Mississippi floods, it would reduce a super-flood somewhere to the extent of 7 feet in the lower Mississippi under conditions at least that prevailed before the recent modifications in the Jadwin Plan. I also estimated that if these reservoir projects, the entire system, of a billion and a quarter dollars, were operated for local flood protection, the incidental benefit to the Mississippi River in a super-flood would be reduced to something on the order of 4 or 5 feet. Referring to page 58 of House Document 259, super-flood A was 3.6 feet, super-flood B, that is a little different assumption given there on page 60, it showed 5.9 feet. We had two types

of super-floods there, one was A and assumed one build-up from the tributaries and B assumed a little different one. The first figure is the reduction at Columbus for A and the second figure is the reduction at Columbus for B. I would [fol. 1034] say in the neighborhood of 4 feet then—something like that. I testified in the Ashwander case and the following testimony of mine in the record in that case, at p. 775, seems to be in substantial agreement: "If the reservoirs were operated solely for tributary protection, reduction would be approximately 4 feet."

Of course, I don't remember exactly what I said three years ago, but that is the record and I assume it is correct. I would not seriously quarrel with it. In this total of the two plans of reservoirs, there was storage capacity on the Tennessee River of somewhere around 10,000,000 acre feet, about 40 per cent of the Ohio. The 98,000,000 acre feet, of course, includes a great deal of storage below Cairo, which we should not consider in any comparison at Cairo. When you are talking about 4 feet at Cairo, there is no comparison with the 98,000,000 acre feet which includes storage below Cairo. I will state that the 10,000,000 acre feet is approximately one-tenth of the entire system, including both reservoirs above and below Cairo.

As I recall my system of reservoirs that was considered in House Document 259 (Defendants' Exhibit 32), on the Tennessee River was 21 reservoirs. The reservoirs in the TVA Unified Plan I believe are Gilbertsville, Pickwick, Wheeler, Chickamauga, Norris, the dam on the Hiwassee and the dam on the Little Tennessee. I don't know the exact tributary on which the Fontana Dam is located, but it is above Chattanooga.

Plan No. 1 described in Defendants' Exhibit 32 was a system of tributary reservoirs to be operated primarily for Mississippi flood protection. Plan No. 2 was a system of tributary reservoirs to be operated primarily for local flood protection. The Mississippi River Commission recommended the general principle that the Federal Government, in so far as it did anything by way of contribution or [fol. 1035] otherwise, would aid Plan No. 2. In the particular case of the Tennessee, Plans 1 and 2 can be merged, or do merge very easily because of the proximity of the Tennessee and the Mississippi, and frequently it is possible with the Tennessee reservoirs to gain both benefits.

"Q. Yes. Did you understand me to ask whether plans 1 and 2 could be merged?

A. I answered your question and then I explained, so I believe, sir.

Q. Well, you didn't understand me to ask that, did you?

A. I don't understand what you are talking about now."

There was a dam at Aurora included in Plan 1, but there was no dam at Aurora included in Plan 2. A short answer is that in Plan No. 2 there was no dam at Gilbertsville.

July 29, 1935, is the date of the letter of transmittal signed by George H. Dern, Secretary of War, transmitting to Congress the report, Defendants' Exhibit 32. That was before Congress prior to the enactment of the Mississippi River Flood Control Plan in the Act approved June 15, 1936. I believe the Act you are referring to is the Omnibus Act, that is, the Flood Control Act which was approved June 22, 1936. There were two Acts about the same time, both dealt with flood control, one specifically with the Mississippi and the second Act dealt with the country as a whole and includes a number of provisions that affect the Mississippi, that is, 2 or 3 specific provisions regarding the Mississippi. The one that modified the Jadwin Plan is June 15, 1936.

Turning to Defendants' Exhibit 32, I cannot answer specifically that the reservoirs set forth in Plan No. 2 provide for no dead storage, as dead storage is something that has been a very much misused term. With reference to Project No. 74, the Milliken Branch on page 46 of that Exhibit, shows a capacity of 103,400 acre feet, and that is the flood control capacity we considered there. It is the [fol. 1036] capacity that we have of storage there. All of the storage capacities there represent the total storage capacities of those reservoirs. This study considered a certain amount of storage. The results are immaterial as to whether or not that storage would be obtained in that particular reservoir. We might get 10,000,000 acre feet of storage on the Tennessee River in a different manner. We might not get any in that particular reservoir. We might have somewhat greater storage in another reservoir. We might have an entirely new site, but the results would be essentially the same as we show for this particular study.

I am still correct in my statement on direct examination that I could not answer a question because I had to know where the total 5 million feet of acre storage in the chain of dams was located, how much was in each dam and where each dam was. That is not the difference between a hypothetical question and a practical study. I have worked out various schemes here and they substantiate the answer that I gave you. Assuming that my 10,000,000 acre feet on the Tennessee of storage was all on the Clinch River, the result would not be the same. It is obvious that if you put more storage on one reservoir than there is stream flow above it, you would not obtain the same results. But if you have essentially this type of a system with storage distributed between the main river and the tributaries, storage reservoirs placed below where you have sufficient stream flow, you can get essentially the same results as we obtain with this system.

In the estimates in Defendants' Exhibit 32, it is not assumed that the entire storage in acre feet will at all times be available for flood control purposes. The detailed plan of operation worked out assumes a sufficient filling of certain groups of reservoirs and filling on a rather complicated system of prediction for others under plan two so that at any moment—

[fol. 1037] Paragraph 53 on page 26 reads:

"The reservoirs selected as comprising the best system for the control of floods on each of the above main stem tributaries would also furnish local flood control on the minor tributaries, upon which the majority of the reservoirs are located. These several systems have been combined into a comprehensive system embracing the entire Mississippi Valley and its incidental effect upon the lower Mississippi River floods determined. Several reservoirs were added in this office, which were patently advantageous to the lower Mississippi River. This combined system is designated as plan II in the report."

In other words, each separate local system had its own method of operation, which I did not report in this report, and operating under that system the combined results were those that were shown at Cairo. That is a local system of operation described in the paragraph that I read, used to furnish local flood control as distinguished primarily

from flood control work on the Mississippi, but including incidental Mississippi flood control. We found in case of the Tennessee particularly, it was possible to gain a large measure of benefit locally and also Mississippi flood control protection. The storage is merely filled up in flood season in a number of the reservoirs. It might be used for several purposes other than flood control. We assumed that would be filled up during the flood season and then, irrespective of the uses made of the water, the results would be obtained from the space available to store the flood. The way we get one answer for protection from flood if we assume that flood came along in January and that 8,000,000 feet of the 10,000,000 acre feet in these reservoirs was unfilled and available, and in another case a flood came along in April or May on the Mississippi and then there was only 500,000 acre feet available, is because where you lose in one you made up in another.

[fol. 1038] "Q. Your testimony is that if these Tennessee River tributaries were filled up by the first of April, so that there was left only available 500,000 acre feet of storage on the whole system on the Tennessee, out of your assumed figure of over 10,000,000 acre feet, and it so happened in that year the big Mississippi flood came along in May or early June, that would nevertheless be effective to produce the results that you have testified to?

A. We did not find that to be the case from the studies that we made."

We were routing several floods through there and determined from the results of actual floods what we might expect from future floods. In routing the floods through these reservoirs, we assumed 10,000,000 acre feet was available at the beginning of the flood season. I was asked the following question and made the following answer with reference to this flood control system in my testimony in the Ashwander case:

"Q. But, at the critical moment you are assuming the primary use of that space or capacity?

A. That space would be available for use when necessary."

I see no conflict in that answer and in the statement I have just made. The answer, that space would be available for use when necessary, I interpret to be in accordance with my

present statement that at the beginning of the flood season the space would be available for the control of floods.

"Q. You testified that if this ninety-eight odd million acre feet of storage were operated primarily for Mississippi flood control it would reduce the stage of a super flood by seven feet. Assuming that all of these tributary reservoirs were filled by March 1st in a given year, and that you had a super flood in the Mississippi River in May of the same year, how much would that system of storage reservoirs reduce the stage of that flood?

A. Well, that would probably accomplish a very considerable reduction, because if they were filled in March I can see no reason why they could not be pretty well drawn down, at least within prediction distance, before the May flood.

Q. You assume they will be drawn down?

[fol. 1039] A. After the flood season is passed. Take Gilbertsville as a specific example. It is located within, about a day or two days travel of Cairo. After the flood crest has passed at Cairo and the river is falling I see no reason why that Gilbertsville storage should not be drawn down. Then the space is available for the May flood.

Q. Well, Mr. Clemens, let's not quibble about the matter. Laying that aside, there cannot be any argument, can there, but that this tributary storage can be useful only to the extent it is empty at the time of the flood, or when it is needed for flood storage?

A. Well, there are two things there, Mr. Jackson, that you have to consider. During the flood season rivers generally rise, building up a base on which the flood crest is eventually placed. Now, if during that flood season we can reduce that base, that eventually reduces the crest in the amount that we reduce the base, and then such storage as we may have available at the crest can be used to further reduce the crest.

Q. Well, I am willing to take any answer. If you will just tell me a flood storage reservoir is as good for flood control purposes when full, as empty, from your point of view, I am willing to accept it.

A. Of course, you are assuming after we control the flood, we have this super flood of yours.

Q. I am not assuming anything. I just want a bare fact. Is, in your opinion, a flood control reservoir that is full just as good as one that is empty? You can answer that yes or no.

A. Let us get it exactly. You want; is the flood control reservoir that is filled, as good as one that is empty for a flood in the future, or one that has already been stored in the reservoir."

Of course, if you are going to assume some kind of a theoretical flood coming along on top of a full reservoir, then the only value of that reservoir in reducing the crest of that flood is that it will create such a pulling down of the base of the flood as has already been accomplished by the reservoir. Whether it will aid in taking care of any character of flood depends on the character of the gates on the reservoirs. For instance, take a super-flood with Norris reservoir full up to 1020, and let the Jackson or Kurtz super-flood come along on top of that full reservoir, we [fol. 1040] could store that flood by letting it flow over the top of the gates and still get a very material reduction in the flood below the reservoir.

I do know that the top at Norris is 1034. I also know we can go up to 1040, some odd feet and control the flood by some thousands of acre feet, just like Mr. Kurtz' detention basin on top of the dam. That is not valley storage at an artificial elevation, it is a retarding basin or detention reservoir on top of the reservoir that they have not taken advantage of.

"Q. You testified a little while ago that a retarding basin would very seriously damage the Mississippi?

A. The system of flood control on the Tennessee with retarding basin plan, I do not think would be—I believe would be disadvantageous to the Mississippi River.

Q. So the effect of this uncontrolled storage that you find on top of these TVA reservoirs is detrimental to the Mississippi?

A. It is not detrimental. It is not of as great value as stored control water. Its value is less than that of controlled water, admittedly."

It has some value if it detains water.

Referring to the effect of the 1927 flood on the Tennessee River shown at the middle of page 59 of Defendants' Exhibit 32, Plan 2, on the assumption of a super-flood during which we placed an extreme low flow period in the Tennessee River opposite the crest of the Mississippi, shows a slight increase in the flow of the Mississippi. The explanation is that this 1927 hydrograph shown on page 59 had been offset to make the low water period of the Tennessee coincide with the crest period at Cairo. Taking the actual 1927 contribution, we found a very considerable reduction. If you go to the actual 1927, which you find at the middle of page 63, hydrographs 1927, "Confined reduction of Plan 2," the crest flow, 192,000, and the modified flow 101,000, a reduction of 90,000. With Plan 1 for the [fol. 1041] same flood on page 57, we would be able to reduce the crest flow of the Tennessee of 192,000 to 6,000 second feet. From an examination of the past contributions of the Tennessee to the Mississippi, we find that the minimum is about 150,000, which is considerably more than the assumption made on page 59 referred to in the question. It was an assumed condition of a low flow from the Tennessee meeting a super flood on the Mississippi. It was not the actual flow on April 5, 1927. Those have been offset arbitrarily in that program to make an assumed condition. It is not an actual condition. The actual condition is the one I gave in explanation. The flow on April 5, 1927, is offset in its combination with other floods.

Assuming 7,000,000 acre feet available for storage in the TVA reservoirs, I answered a question on direct examination whether it would be possible to store 150,000 second feet during the crest of the flood. I understood that the 7,000,000 acre feet of storage would be located at dams such as Gilbertsville, Wheeler, Pickwick, Norris, Hiwassee, with a considerable portion of it at Gilbertsville. I had to know approximately how the storage was distributed among those dams. I had to know there was a considerable volume at Gilbertsville to make it effective. As I recall, it was something like in the neighborhood of three and one-half million acre feet at Gilbertsville.

I stated that valley storage is nothing more than a space occupied by the flood in going down the valley. My reason for stating that it was not really storage because it was empty unless there was a flood there was that storage

involves in my mind control, and valley storage is merely an uncontrolled space occupied by the flood. I did not mean to draw the distinction between controlled and uncontrolled storage. I gave a definition of valley storage which I believe is correct.

[fol. 1042] "Q. Of course any flood control reservoir, if used only for flood control, stores water only in time of flood, doesn't it?

A. Oh, it might store water on the advancing wave of the flood, and carry it over to be used at low water. That is possible."

A storage reservoir reserved for flood control will not necessarily only be filled at times when there is a flood or anticipated flood. That is the old theory of the retarding basin, but our more recent studies, and what we have learned after ten years of constant consideration of reservoir problems, leads to the conclusion that the storage should be controlled.

My answer to the question whether it is not true that any reservoir that has its space reserved solely for flood control actually is used for storage only at the time of flood, or when the flood is anticipated, is that if you have storage space available for flood control, it will be more effective if it is held in complete availability for flood crest.

I am in the office of the President of the Mississippi River Commission. It was approximately 1931 when I went to that office. Prior to that time I was in Vicksburg with the District Office. I am generally familiar with the report dated May 1, 1932, which was published on the improvement of the lower Mississippi River for flood control and navigation, prepared under the direction of Brigadier General T. H. Jackson, President, Mississippi River Commission. I was not connected with the preparation of it but I am generally familiar with the contents. I generally agree with the following statement from page 95 of that report:

"No discussion of the river discharge is complete without consideration of the reservoir possibilities of its basin. The function of a storage reservoir is to furnish temporary storage for surplus flood waters which may be released gradually as stream flow. This storage of course reduces

the maximum stages and discharges by prolonging the [fol. 1043] period of high water and distributing the discharge in a more uniform rate, and over a greater time period, than would otherwise be the case. Reservoirs are not necessarily all artificial; lakes, side basins, swamps, backwater areas, and the river channel itself, all provide for the impoundage of upstream flow. In a stage of nature, the entire alluvial valley of the lower river was subject to flood inundation and its enormous reservoir storage capacity retarded both discharge and stage. The erection of levees has greatly restricted the width of the natural floodway with the consequent enormous reduction in the reservoir capacity of the lower river. Backwater areas still exist, however, at the mouths of the lower tributaries (See Table I) and the channel storage between levees is a very appreciable factor in the consideration of flood heights and discharge. Table XX affords an indication of the channel reservoir capacity of the lower river."

I object to one word in the middle of that statement where it says that lakes, side basins, swamps and backwater areas provide for "impoundage" of stream flow. They don't impound anything because that involves control and they don't control it. I can not agree with that word. I may find there is some principle I don't agree with, but generally speaking, I agree with it.

On my direct examination I stated that the plans for the Mississippi super-floods involved somewhat over 3,000,000 second feet at the mouth of the Arkansas and that no increase was provided for below the mouth of the Red River, that is, that the water in flowing through the space between the levees, and the effect of the Yazoo backwater, and the Red River backwater on this crest that comes down the river approximately compensates for the additional flow that may come in from the Red. In other words, the natural valley storage between those points will reduce the peak flow for the additional flood water that comes out of the Red River in time of flood.

The article which I wrote for the American Society of Civil Engineers shows on page 888, Table 2, "Origin of 1927 flood, Red River Basin," that the total computed run-off of the Red River above Denison, Texas, was 716,000 acre feet. Denison is a long ways up above the mouth of

[fol. 1044] the River. The total acre-feet discharged would be a lot more before it got to its mouth. There is a total greater run-off as you increase the total drainage area. The total at the mouth of the Red River above the head of the Atchafalaya is 16,746,978 acre feet, which includes the Red and Ouachita. They come in a short distance above the mouth of the Red, about 90,000 square miles. As I recall this table, that was the volume of the 1927 flood. As I recall the set-up, the super-flood of the Mississippi assumed the same flow out of the Red and Arkansas as came in in 1927. That is, we assumed the 1927 flows from those streams would meet the crest coming down the river.

June floods are not ordinarily very high on the Mississippi. I would limit the period for major floods to say May 1st to the 15th. The June floods are normally Missouri River floods. Sometimes there are contributions from the other tributaries, but they are not normally so high. The table on page 403 of Exhibit 116 shows a controlled storage of 8,731,000 acre feet for the TVA project reservoirs. I don't know exactly what is meant by the term "controlled storage," but we will pass that.

I have not gone into such an exhaustive study of the power resources of the Tennessee as would be required to answer the question as to the amount of power storage there must be in the tributary and other reservoirs on the Tennessee River in a dry year like 1925 by February 1st to March 1st, in order to produce firm power capacity of 660,000 kilowatts, that is, continuous 24 hour capacity, and to generate 5,780,000,000 kilowatt-hours of firm energy in a year.

"Q. So that in answering Mr. Fly's question you answer without any study or consideration of what storage must have been retained in the TVA tributary and main stream reservoirs in order to carry out their announced or reported intention to Congress of creating a hydro-electric system that would have a firm capacity of 660,000 kilowatts [fol. 1045] and a firm energy output of 5,780,000 kilowatt hours in a low water year?

A. I did not have the detailed figures as to the power output and these other power capacities stated, but I answered based on the studies that I have made of this and

other streams which indicate that it would be feasible to devise some means of obtaining a combination of these various purposes."

In answering Mr. Fly's specific question, he gave me an assumption of 7,000,000 acre feet, and I gave him my conclusion as to what would be obtained. In none of my testimony am I undertaking to testify whether or not any particular volume of acre feet will be available and provide an electric system to produce the quantity of power stated. That is up to the TVA engineers to tell how much they are going to have and how they are going to operate it.

I agree with the following statement in the report of the Chief of Engineers in Defendants' Exhibit 32 on page 3, paragraph 8:

"In the separate reports on the tributaries of the Mississippi River made under the authorization contained in the River and Harbor Act of 1927 in accordance with the provisions of House Document No. 308, 69th Congress, First Session, the most suitable sites for storage reservoirs on these tributaries were developed, and the effect of such reservoirs on the floods of the Mississippi was computed. In each case it was found that the operation of any reservoir, or isolated group of reservoirs, would have small effect on Mississippi River floods."

That paragraph is contained in the report of the Chief of Engineers, forwarding the Mississippi River Commission's report, and is the comment of the Chief of Engineers on that report. I think in a general way, considering isolated projects scattered over the entire Mississippi River drainage basin, that it is correct. But if you have the development of some one tributary that shows consistently that it is a contributor to Mississippi River floods and provided sufficient control on that tributary to hold out some appreciable amount, that it would be of value in itself. [fol. 1046] The Tennessee River, due to its proximity to Cairo and the Unified Plan being carried out on that stream would, in my opinion, fall within that classification, and within the limits that the floods of the Tennessee River could be stored, or the Tennessee River could be so operated as to provide appreciable reduction of flood heights at Cairo. Subject to my comment—the comment of the

Chief of Engineers in House Document 259, Defendants' Exhibit 32, is correct.

I am familiar with the article in Transactions, American Society of Civil Engineers, Volume 100, for 1935. The Transaction is a reprint of the article, including the comments of various engineers thereon. The article was originally prepared as a thesis at the University of Michigan for a graduate degree. The following is a part of my opinion:

"The demands of water power and flood control are more or less contrary. The power reservoir is filled as rapidly as possible during periods of high flow to insure a maximum yearly output. When the reservoir is full and high flows occur they are merely passed over the spillway. On the other hand, the flood-control reservoir is kept as low as possible, in order that the storage capacity may be available to store the peak of the abnormally high floods. A large power reservoir is frequently a very efficient reducer of small floods, but it may have little or no effect on large floods should they occur at the time of year when the reservoir is nearly full. A flood control storage reservoir, even with a minimum draw-down limit, would permit of very irregular development of water power. There would be practically run of river operation through the minimum head during long periods of ordinary flow when it is desired to keep the reservoir low. There might be little or no power development during the storage period, depending on the quantity of water that could be released under the method of operation adopted. During the emptying period after the flood, fairly efficient, but still variable power development might be obtained."

I would like to extend that by reading another paragraph of that same report. That states only a part of my opinion. In so far as it goes, it is correct. There are additional facts in that report that pertain to some exhibit that should be read to complete my opinion.

[fol. 1047] "Mr. Fly: Should not the witness be permitted to read the rest?

Judge Allen: He may.

Mr. R. T. Jackson: If your Honor please, I do not understand on cross examination the witness may read an article.

Judge Allen: The witness may explain his statement.

Mr. R. T. Jackson: May an exception be noted to the witness reading an article he is asked about on cross examination?

Judge Allen: The exception may be noted."

(The witness continued to read from the same page of the report, as follows:)

"By sacrificing some measure of flood protection and power production, a combined use of the same storage is sometimes feasible. Floods can be expected to occur at certain seasons. Power demands for the locality have a certain seasonable variation. Operating schedules for plants in a system with other power producers might be arranged to permit the seasonal use of production from a water-power plant at the flood control reservoir.

"These factors may be combined to develop a rule curve for operating the reservoir to obtain the best possible use for both functions. Such a curve would consist of a schedule of elevations of desired water surface in the reservoir, set arbitrarily, and to be obtained throughout a year. For the conditions set forth in the preceding paragraph such a curve would provide that the reservoir be kept at a low elevation during the flood producing period. As this period closes, increased elevations are permitted to provide increased head and storage for the low water season. During the low-water season this storage is drawn down, regulating the power output and making certain that the reservoir is low at the beginning of the next high-water season. An interesting example of such an operation is a stream in California,"——

"Mr. R. T. Jackson: I object to his going into a collateral question about some other topic."

I think that explains my remark. I would like to call attention to the fact also that this paper was prepared long before any of this discussion over the Tennessee Valley had been thought of.

[fol. 1048] "Judge Allen: It will in general be the policy of course to permit witnesses to state their answers and then explain their answers. When the Court gives such permission to a witness, the permission is given by the Court. Technically, it is not a part of the cross examination. Neither is it a part of the case for opposing counsel.

When the Court permits the witness to explain his statement, the Court has asked for that information, and that privilege is and will be extended equally to both parties.

Q. Mr. Clemens, in the paragraph which you have just read where you said it explained this paragraph, by pointing out what could be done by sacrificing some measure of flood protection and power production, you spoke of operating schedules for plants in a system with other power producers. If you had a situation where all of the plants that you had in the system were flood control projects for the same stream, and to serve the same power load, as well as some flood on that stream, the integration would not help much, would it?

A. The integration of such a system would depend on its extent, the character of your other plants, how the draw-down might be permitted at one place and utilized at another. There are very many complicating factors there. I cannot answer that specifically.

Q. I tried to help you by eliminating those complicated factors.

A. You cannot eliminate them; they are there.

Q. (Continuing.) By saying it was one system of flood control reservoirs to take care of one flood on one water shed."

In the 1937 flood, the amount of water that went through the Birds Point-New Madrid floodway was just slightly under 500,000 cubic second feet at the crest. The floodway was not completed in 1937 to the extent that the levee had not been cut down. The original design figures of the New Madrid floodway contemplated that it would carry in a super-flood approximately what was actually carried in 1937. I do not remember off hand the total estimated cost of the Birds Point-New Madrid floodway. My recollection is that the cost of the right-of-way was about \$6,000,000. The levee is additional. I may be somewhat in error.

The Birds Point-New Madrid floodway was considered at [fol. 1049] the time of the passage of the Act to be sufficient to draw down the Cairo stage something a little over 6 feet, between 6 and 7 feet. I assume that the figure of \$5,000,000 available for completing the Birds Point-New Madrid floodway in Committee Document 1, 74th Congress, First Session, under date of February 12, 1935, page 3, is

correct. I just don't carry that figure in my mind. I did testify, however, that the estimated cost of this comprehensive reservoir plan was something around a billion one hundred twenty-five million dollars.

Congress has authorized under the Markham Plan works for the completion of the Mississippi flood protection system totaling an estimated cost of \$272,000,000, but they have not made those appropriations. The only appropriation we received was this year, \$22,500,000, of which \$4,000,000 was impounded. They also gave us \$7,500,000 of relief funds to expend without restrictions. It gave us about \$25,000,000 that has actually been appropriated under the Markham Plan. That is the amount that has actually been made available to us to date. The Act of June 15, 1936, authorizes \$272,000,000. We have under the Omnibus Act around a half million dollars additional. There are certain works under the Omnibus Act that are also on the Mississippi River. The Tiptonville-Obion levee is one. There is about a half million dollars in there. There is also some work on the Arkansas.

The present flood protection plan is the modification of the Markham Plan that was authorized by the Act of June 15, 1936. The following from Committee Document No. 1, 74th Congress, First Session, being a letter from the Chief of Engineers to the Chairman of the Committee on Flood Control, House of Representatives, Washington, D. C., dated February 12, 1935, paragraph 21, page 7, is the statement that includes the changes that were made in the so-called Jadwin Plan by the Act of June 15, 1936:

[fol. 1050] "The modifications of the project recommended by the Commission have received my careful consideration, and have my general concurrence. These modifications are as follows:

"(A) A complete revision of the floodway plans between the Arkansas and the Red Rivers to reduce the area submerged in extreme flood, by eliminating the Boeuf floodway and substituting therefor a floodway on the east side of Macon Ridge, with a controlled inlet in the vicinity of Eudora, and a back protection levee extending from this floodway north to the Arkansas River.

"(B) A revision of the floodway plans in the Atchafalaya basin to provide for additional protection of the valuable lands at the head of the basin east of the Atchafalaya River, by a floodway with a controlled inlet above Morganza.

"(C) The protection of the developed lands at the southern end of the Atchafalaya basin by an extension of the protecting levees and the construction of a new outlet to the Gulf.

"(D) Acquisition of flowage rights in floodways at reasonable costs within a limitation based on total 1934 assessed value.

"(E) The adjustment of drainage works at Federal cost as made necessary by levee construction.

"(F) A six-year program of work to increase the flood-carrying capacity of the river channel between the Arkansas and the Red in the middle section of the river, and of the Atchafalaya River in the southern section, and a continuation of bank stabilization.

"(G) Flood-control works in the St. Francis and the Yazoo basins to protect against the recurring floods of the tributaries to which these areas are now exposed.

"(H) The construction of roads on levees, to facilitate their better upkeep and to provide accessibility in flood emergency. This in addition to road adjustments agreed upon in connection with floodways."

In addition to those changes, the general flood control Act passed that year by Congress contained certain provisions that followed the recommendations of House Document 259. That Act is Public Act 738, 74th Congress, House of Representatives, 8455, June 22, 1936, page 18, which authorizes under the heading "Ohio River Basin Reservoir System for Protection of Pittsburg", and then further on down, "Reservoir System for Reduction of Ohio River Floods Below Pittsburg." Those two systems of [fol. 1051] reservoirs authorized by that Act were a portion of the reservoirs included in this House Document 259, 74th Congress, First Session. That authorization is in accordance with the recommendations of the Mississippi

River Commission, that the Federal Government adopt a policy of encouraging and participating in the construction of feasible tributary systems which will fit into the ultimate system for control of the lower Mississippi River floods. Those levees for the protection of Pittsburg against floods are not under the Mississippi River Commission, but under the Chief of Engineers.

The Mississippi River Commission is composed of three Army Engineers, three civilian engineers and one member of the Coast and Geodetic survey. Prior to 1928, they made their recommendations direct to the Secretary of War. Since that, they make a report to the Chief of Engineers, who in turn reports to Congress.

The following statement made by me in an article published in Civil Engineering for June 1937, entitled "The Mississippi meets the 1937 Flood" at page 183, correctly presents my opinion:

"Jadwin plan levees and recent cut-offs function perfectly under severe test. It is surprising that there should have been so much hysteria as the flood approached the lower Mississippi Valley. The country had enough confidence in the engineers to give them over \$300,000,000 for the Mississippi River flood plan. Why then did people become unstrung when the floods descended upon that plan? Now that the flood has subsided it is clear that the plan worked about as expected—and that the flood was considerably less than the protection provided against it. If the men who know and love 'Old Man River' can now have an opportunity to sew up its wounds caused by the 1937 flood and build up those vital organs which were a little weak—if that is done, I am confident the next flood will be held within bounds as was this one."

Redirect examination:

I stated in my original direct examination and I am firmly convinced that any method for reducing flood heights that can be utilized, meets my enthusiastic approval.

A number of the reservoirs recommended by the Mississippi River Commission under House Document 259 on [fol. 1052] the tributaries of the Ohio are under construction at the present time.

(The witness was excused.)

[fol. 1053] EDWARD H. SARGENT was called as a witness on behalf of the defendants and, having been first duly sworn, was examined and testified as follows:

Direct examination:

My address is Albany, N. Y. I am a Civil Engineer. I received my technical education in the class of 1907, at the Massachusetts Institute of Technology. From 1907 to 1920, with the exception of the period during the war, I was engaged in various capacities for the New York State Water Supply Commission, such as the Conservation Commission, who were engaged in a comprehensive investigation of the water resources of the various streams in New York State. For the last five years of that time, I was in charge of those investigations. This work required complete field surveys and office studies resulting in comprehensive plans for the full utilization of the water resources of the various rivers in New York State. In 1920 that work was transferred to the State Engineers' Department, and I continued in its charge. For the next two years I was also engineer to the New York Power Commission, which had supervision over the licensees of water power developments at Niagara Falls for the power companies who were using that water under Federal and State supervision. During that time I also designed and began the construction of two hydro-electric plants on the Mohawk River, the principal tributary of the Hudson, of 16,000 horse power each. In 1923 I was appointed Chief Engineer of the Hudson River Regulating District, which position I hold to date. In the last ten [fol. 1054] years I have also done general consulting work on water questions. I have occupied my present position as Chief Engineer of the Hudson River Regulating Commission since 1923, practically since the district was created.

"Q. Will you describe briefly the nature of your work?

Mr. R. T. Jackson: Just a minute, I object.

Mr. Fitts: I have a right to qualify the witness, if not anything else.

Judge Allen: Objection overruled.

Mr. R. T. Jackson: Exception."

The Hudson River Regulating District is a public corporation created under Article VII of the Conservation

Law of the State of New York. The provisions of that statute provide for the creation of regulating districts for the construction of storage reservoirs where required by public welfare, including public health and safety. The Hudson River Regulating District was created under the statute in November, 1922, and the members of the Board appointed by the Governor immediately. The District is a public corporation, entirely separate from the Government of the State of New York, and finances itself entirely independent of the State of New York. Under the law, the District is directed to prepare a comprehensive plan for the regulation of the flows of the rivers within the district, and immediately after my appointment I began the preparation of such a plan which calls for the eventual construction of 16 storage reservoirs, having an aggregate available capacity of over 2,000,000 acre feet. On the completion of that plan, the Board proceeded with the construction of the largest of these reservoirs, the so-called Sacandaga [fol. 1055] reservoir which is located on the Sacandaga, one of the largest tributaries of the Hudson River about 65 miles north of Albany. I prepared the plans for the construction of this reservoir, which was completed in the early summer of 1930. This reservoir has a total capacity of 867,000 acre feet. Since the completion of this reservoir, I have been in charge of its maintenance and operation.

"Q. And what is the nature of that operation?

Mr. R. T. Jackson: Now, I think I have reached the point where I am entitled to raise the question of whether we are going into collateral issues as to another reservoir.

Judge Allen: Just a minute.

Mr. Fitts: I am qualifying the witness to express an opinion upon Norris reservoir, and on his opinion as an expert, that has something to do with it.

Mr. R. T. Jackson: I object to that question because this is nothing more than a back door method of involving us in a collateral issue as to the operation of the Sacandaga reservoir, how it is built, and everything. We bring in the collateral issue if we are going to do that. He has shown this gentleman built the reservoir, and the operation of it, for whatever that is worth.

Mr. Fitts: I want to know whether he operates it solely for flood control or for combined purposes.

Mr. R. T. Jackson: That is an ultimate conclusion that if we are going into, we have to go into the whole operation of the Sacandaga reservoir, and what it is.

Judge Allen: Just a moment, please. He may answer. You may have your exception.

Mr. R. T. Jackson: May I say this, that if the Court is going to permit this inquiry, I wish we could have an opportunity to file some authorities.

Judge Allen: The Court will permit the witness to answer the question. You may have your exception.

Mr. R. T. Jackson: Exception please.

[fol. 1056] A. The Sacandaga reservoir is operated for the multiple purposes of flood control and low water regulation, for sanitary improvement, increase of firm power at power plants, and a benefit to navigation.

Q. Is there any power generated at the dam itself?

A. Yes sir, there is.

Mr. R. T. Jackson: May I understand clearly—I don't want to interrupt, if the Court has reached a firm conclusion. If I am objecting too early, then I want to remedy that.

Judge Allen: The Court expects you to make a specific objection and exception to every question that you deem to be objectionable.

The Court is not at all worried about any objections made.

Mr. R. T. Jackson: It takes the time of the Court, is my concern. I object to this question and move to strike it out and also the previous answer as involving a collateral issue, not within the issues in this case.

Judge Allen: The objection is overruled. The Court holds it is competent to show the experience of this witness in the projects which have been under his direction in order that he may testify as he understands he is asked.

Mr. R. T. Jackson: Under those circumstances may I say that that merely permits the witness to bring in every collateral issue within his memory, in the guise of experience.

Judge Allen: You may have your exception.

He may answer it.

A. There is a power plant that has two 17,000 horse power units in the plant.

Q. For how many years now have you been in charge of the operation of that project for the purposes which you have mentioned?

A. We started to impound water in March, 1930.

Mr. R. T. Jackson: My objection is on the ground it involves a collateral issue.

Judge Allen: Overruled. You may have your exception."

[fol. 1057] I am familiar in a general way with the location and design of Norris Dam and I have seen and inspected its facilities since it has been completed and in operation. The last time I saw it was last Sunday. The particular feature of design incorporated in Norris Dam that is useful for flood control, which is not ordinarily found in dams intended primarily for power development, is that Norris Dam has a larger discharging capacity through its eight sluice gates, and the power plant in connection with the dam, than is ordinarily found in power dams. The eight sluice gates have, as I remember, a capacity of 36,000 second feet, assuming the reservoir to be at elevation 1020, and the power plant has a discharging capacity of approximately 9,000 cubic feet per second. That capacity for releasing water is very beneficial in matters of flood control, because if we shortly had a flood on the Tennessee River and on the Clinch, presumably storage would be impounded in the Norris Reservoir and it would be desirable to get back that impounded storage at as early a date as possible in anticipation of possible subsequent spring floods, so that large capacity facilitates emptying the reservoir quickly. In my opinion, the discharge capacity at Norris Dam is fully adequate.

I have made quite an elaborate study of the Clinch River with respect to the hydraulic conditions. I made some of it in connection with my work in the Ashwander case, and I have supplemented it by work during the past 2 or 3 months.

"Q. Mr. Sargent, is power developed at the Sacandaga reservoir throughout the entire year?

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Mr. R. T. Jackson: We object to that for the same reason, it involves collateral issues.

Mr. Fitts: There is already testimony in this record on that point, may it please the Court.

[fol. 1058] Mr. R. T. Jackson: If so, then the objection is also that it is cumulative.

Judge Allen: The objection is overruled. The Court is conscious that certain testimony of this kind has been allowed to go in without objection.

A. We close down—

Mr. R. T. Jackson: On cross-examination, if your Honor please.

Mr. Fitts: Without objection.

Mr. R. T. Jackson: I understand the rule is very different. On cross-examination I can, if I want to take my chance on the witness' answer, I can cross-examine him on matters that I cannot prove by analogy. If the Court has ruled I will not extend my argument. I want to note my exception.

Judge Allen: You may note your exception.

A. We close down the power plant at the dam during periods of extreme floods on the main stream below, so that we would not increase the flood at those points by any water being released by the generation of electricity at the power plant.

Q. On the average about how much of the time during the year is the plant closed down?

Mr. R. T. Jackson: The same objection, involving a collateral issue at another plant over a period of several years.

Judge Allen: The objection is overruled. The Court feels that testimony of this kind may be elicited, in order that this witness may testify concerning Norris Dam.

Mr. R. T. Jackson: May an exception be noted? And may I say, if your Honor please, I don't want to irritate the Court, but I regard this as so serious that—not from his testimony, but the principle, because if it is true that an expert witness may testify about everything in his experience in order to illuminate his testimony, then we are entitled to recall our witnesses and have them do the same thing, put on every project they ever worked on.

Judge Allen: You may have your exception.

A. The power plant is generally closed down quite continuously from about the 20th of March, which is the ap-

proximate date of the beginning of our spring floods, until [fol. 1059] after the flood peak has passed. It depends a great deal on the elevation, the elevation to which the water has risen in the reservoir, and the stage of the river downstream from the dam. On the average I would say it was from a month to a month and a half each year.

Q. Mr. Sargent, will you tell us whether or not the storage capacity at Norris Dam, in proportion to the drainage area which it controls, is greater or less than the storage capacity at Sacandaga Reservoir?

Mr. R. T. Jackson: The same objection.

Judge Allen: The objection is overruled.

Mr. R. T. Jackson: An exception noted, please."

The storage capacities of Norris and Sacandaga reservoirs are very closely similar, bearing in mind the difference in the watershed tributary to the dams, and having in mind also the difference in the rainfall and run-off at the respective sites. The storage capacity of the Sacandaga reservoir is 867,000 acre feet. The tributary drainage area is 1040 square miles. The capacity of Norris, between the maximum draw-down elevation, which we call low flow line, to get away from the maximum and minimum, the storage at Norris between 955 and 1034 is slightly over 2,000,000 acre feet, and the watershed on the Clinch at Norris Dam site is 3000 square miles, so they are very closely alike. The run-off, the mean annual flow of the Sacandaga is slightly more prolific on a per square miles basis than is the flow on the Clinch. In other words, the mean annual run-off of the Clinch is about 28 inches per year, and the mean annual run-off in the Sacandaga at the dam site is between 20 and 22 inches a year. The rainfalls on the two watersheds are both very closely alike. They are both about 50 inches a year, but it seems in our watershed a little more of the water gets into the river than it does here.

[fol. 1060] "Q. Mr. Sargent, in your opinion, is it possible and desirable in the operation of a reservoir such as Norris, for the combined purpose of controlling floods in the Tennessee and Mississippi River Valleys, and low-water regulation in dry flow seasons, to devise a schedule of gradually filling the reservoir during the flood season.

Mr. R. T. Jackson: Just a moment. First I want to ask whether that question excludes the production of power or not.

Mr. Fitts: It does not.

Mr. R. T. Jackson: Well, then, I object to it unless it does.

Mr. Fitts: I am coming to that in a minute.

Mr. R. T. Jackson: I object to that question unless that is incorporated in it. I further object to the competency of the witness to testify with reference to flood control on the Mississippi River.

Judge Allen: The objection is overruled. You may have your exception.

Mr. R. T. Jackson: Or on the Tennessee River. I want to complete my objection and have my exception noted.

A. Yes, in my opinion it is entirely possible to devise a schedule of operations of a reservoir such as Norris to govern its operation throughout the entire year for the various purposes for which the reservoir was constructed.

Q. Upon what do you base that opinion, Mr. Sargent?

Mr. R. T. Jackson: The same objection.

Judge Allen: The objection is overruled.

Mr. R. T. Jackson: An exception.

A. Yes, sir. I base it on the fact that prior to the completion of the construction of the Sacandaga reservoir, after a very elaborate study of the stream flow records of that watershed, we prepared what we call an operation chart, which governs the operation, or which I would say is a guide to the operation of the reservoir throughout the entire year. The fundamental thing shown by this operation chart is that it indicates the amount of water that should be released from the reservoir at any particular time, and the amount is dependent upon the elevation of the reservoir at a given [fol. 1061] time. Second, I base that statement on the fact that I made a sufficient study of the stream flow records of the Clinch River and the Tennessee River to justify me in my opinion to say that there is a sufficient similarity in the hydro-logical characteristics of the two streams, that it would be entirely possible to prepare such an operations chart for the operation of the Norris reservoir.

Mr. R. T. Jackson: I move again to strike out the answer because his answer has been wholly a comparison of the

Sacandaga project and its operation with the Norris, which I could not anticipate from the question.

Mr. Fitts: It is his opinion based on the knowledge that he has.

Judge Allen: Objection overruled. The motion to strike is denied.

Mr. R. T. Jackson: May we have our exception please.

Q. Then, Mr. Sargent, as I understand you the operation of a storage reservoir of this character is not a mechanical process?

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A. No. This operation chart which I used on the Sacandaga, and I assume a similar one would be prepared for Norris, would be used only as a guide because as exceptional changes occur in the water conditions, departures will be made from the operations chart.

Mr. R. T. Jackson: Now I move again to strike on the ground that the witness has now brought into his answer a comparison with a project which is a collateral issue to this case.

Judge Allen: The motion is overruled.

Mr. R. T. Jackson: An exception, please.

Judge Allen: The Court deems this testimony has a bearing upon the qualifications of the witness to testify with reference to Norris Dam.

Mr. R. T. Jackson: I want to state our objection goes beyond that because whether it is merely a qualification or not, it is the same thing if it is admitted in the record.

Q. Mr. Sargent, in your opinion in order to obtain effective flood control from a dam such as Norris is it necessary to allocate or assign any definite space solely to flood control.

[fol. 1062] Mr. R. T. Jackson: Just a moment. I object to that question because it is not tied to the Norris Dam or the conditions in the Tennessee Valley.

Mr. Fitts: He has testified of his knowledge as to Norris.

Judge Allen: The objection is overruled.

Mr. R. T. Jackson: The question leaves him at large. Exception please.

A. I would say this, that I think it is helpful that the storage capacity at Norris between 1020 and 1034 is defi-

nately allocated to flood control, but I would consider all of the storage above the dead water level available and useful for all of the purposes for which the reservoir was constructed."

I am generally familiar with the Clinch River flows and the flood season on the Clinch and Tennessee and I am generally familiar with the design and storage capacity of the Norris Dam.

"Q. In the light of your experience, Mr. Sargent, will you state whether or not in your opinion, Norris Dam is a desirable and useful structure for both the reduction of flood flows and increasing low water conditions on the Tennessee River?

Mr. R. T. Jackson: May I ask is that increasing the low water flows for power?

Mr. Fitts: For whatever you want.

Judge Allen: The witness may answer.

Mr. R. T. Jackson: May we have our objection noted unless it is specified whether it is for power? If for any other purpose, we object to the competency of the witness.

Judge Allen: The witness may answer.

Mr. R. T. Jackson: We except.

A. In my opinion, it is a desirable structure for those purposes."

In my opinion, the storage capacity in the Norris reservoir between elevations 955 and 1020 of 1,500,000 acre feet can be operated so as to obtain large benefits for low [fol. 1063] water regulation without any substantial reduction in the effectiveness of the reservoir for flood control.

Cross-examination:

I designed and built two power plants for the State of New York on the Mohawk River at the Crescent and Vischer's dam. The two plants were built for 8,000 horse power capacity, each, and we provided in the plans for the installation of two additional units of similar capacity. I did not design the power plant at Sacandaga. I have consulted on the construction of a number of others, but I have not designed and built any other power plants myself.

In stating that Norris Dam has a large discharge capacity through the generating machinery and through the gates, which is not ordinarily found in a power reservoir, what I meant to say was that the capacity was larger than would ordinarily be found if the developments were purely for power. The generating machinery has hydraulic capacity of about 9,000 second feet. The storage capacity between 955 and 1020 is somewhere in the vicinity of 1,500,000 acre feet. I don't understand any part of it is used solely for power. In my testimony I have understood that that part of the reservoir between elevations 955 and 1020 was used for power only incidentally.

I am not familiar with the Radford development on the New River, but know that there is a power development being made on that river. If it be proved that that has a [fol. 1064] generating capacity with a hydraulic installation of 9000 second feet and large gates clear across the top of the dam for emptying usable storage, I would not think that was a flood control rather than a power reservoir. I don't know anything about the power reservoir. If it is a power reservoir, it is a power reservoir, and that speaks for itself. I think that is a very fine thing.

Examination by the Court:

I think it would be a fine thing, because it would be possible to use the reservoir for flood control purposes, supplementing the power purposes.

Cross-examination continued:

"Q. Well, then you would not agree with Colonel Watkins, that if they were to release that storage in advance of the flood it would be detrimental downstream?

Mr. Fly: I object to cross-examining this witness on Colonel Watkins' testimony in the Radford case. I think that is going entirely too far.

Mr. R. T. Jackson: That is the testimony in this case.

Judge Allen: The Court sustains the objection upon the ground that the question is personal. The Court will not permit questions to be asked which compare the testimony of various witnesses in the case.

Mr. R. T. Jackson: May we have our exception?

Judge Allen: If you want to question the witness about the exhibit, that is a different matter, but leave out the name

of any witness in the case, please. The Court will sustain objections to such questions.

Mr. R. T. Jackson: I understand the ruling, your Honor.

Judge Allen: You may have your exception."

[fol. 1065] I am not familiar with the power installation at London Dam on the Kanawha River in relation to the storage capacity. I am not familiar with that project and would not feel justified in expressing an opinion as to whether it was a flood control project, assuming that the power installation has a hydraulic capacity of 10,000 second feet and that it has large gates across some 300 feet of the dam and has storage capacity which is perhaps 1000 acre feet. I am not familiar with the hydraulic capacity and the storage capacity and the capacity for discharging any storage at the Marmet hydro installation and dam, or at the Wingfield hydro installation and dam on the Kanawha River. I do not know whether it is a fact that the installed capacity of hydraulic machinery in proportion to the entire storage is immensely greater than at Norris Dam.

I am generally familiar with the Muskingum flood control project. A year or two ago I spent about 3 days making an inspection of those projects during the period of construction. Those projects, as I understand, are flood detention projects. They do not include any power problems. As I remember, at some of the dams they were, what are called conservation pools, at which small bodies of water were retained, I assume for recreation or fish life purposes, or maybe for municipal water supply.

I am not familiar with the storage dams at Rock Island, Washington, Martin Dam in Alabama, the upper Tallahassee in Alabama, the storage reservoirs at Blue Ridge on the Ocoee River in Tennessee or the storage reservoir at Waterville on the Big Pigeon. I am not able to draw any comparisons between any of those installations or the one [fol. 1066] mentioned at Radford, London or Marmet, with Norris Dam. I am not familiar with those projects.

There is a hydro plant at the Sacandaga Reservoir, which was built by the New York Power & Light Corporation and which has at all times been operated by the New York Power & Light Corporation under our supervision. They have operated the plant, and they have the contract with our Board, that permits them to use the water as and when we authorize the release for the main purpose for which the

reservoir was constructed. We lease to them the potential water power. We are not under any obligation to supply any firm amount of electricity to anyone. We are not in the power business. We have no contract with the Aluminum Company or the Monsanto or with any of these underprivileged corporations for subsidized power. We have not assumed any obligations to keep the lights burning in any person's homes in New York State at all. Speaking of the power plant at the dam, we simply turn over what power we have, or what raw water we have, to the New York utility to use in an integrated system, and it assumes the headache of having enough to meet demand. Of course, there are power plants downstream, that benefit from water let out at low seasons.

I think the general assumption is that if you build a storage reservoir, you build it to use during the low water season to firm up your power, if you are a power company. It is nothing unusual to find enrichment of flow downstream from storage reservoirs of a power company.

They made an assessment of benefits for this power project in the State of New York. They assessed 4.66% to the [fol. 1067] benefits of flood control and 95.34% to power, and I should like to explain that the statute under which we function provides that the cost of a project shall be assessed against the various public and private corporations in proportion to the benefits inuring as a result of the operation and functioning of the reservoir. But it was held that an interpretation of that meant pecuniary benefits, so that we were unable to assess for the general benefits to the public welfare for protection from disease and illness in the cities of Albany, Troy, Watervliet, and towns along that line, as we were able to assess only for pecuniary benefits.

As a matter of fact, there is a pretty serious sanitary problem in this stream, and in many streams in New York State, arising from sewage pollution and the operation of paper and pulp mills during the low water season. The big sanitary benefits and the big sanitary question is to get enough water in the river during the low water season to prevent unhealthful and unsanitary conditions arising from discharge of untreated sewage and partially treated sewage from cities into these small streams and paper and pulp mill refuse. Paper and pulp refuse is one of the most difficult forms of refuse to deal with.

Sacandaga is about 75 miles above tidewater at Albany. The lowest dam down the river before you get to tidewater is a Government dam leased to Henry Ford. The next dam upstream from the Federal dam which Mr. Ford operates [fol. 1068] under a Federal license is the Waterford Dam, which forms a pool for a connection with the New York State Canal. That is only for the operation of locks. There are a large number of dams of public utilities and manufacturing companies between Sacandaga and the Government dam leased to Ford, that is, about sixteen.

I know that Norris Dam is about 600 miles above the confluence of the Tennessee and Ohio, and we can agree that it would be a long way above tidewater.

I would say there is quite a large difference in snowfall on the watershed above Norris Dam and in the Adirondacks. As a matter of fact, in an average season, we get a pretty heavy snowfall up in the Adirondack country. One type of flood that comes along up there is what we used to call the "spring break-up," with the melting of the snow accompanied in certain cases by a rain. The biggest flood in history was March 18, 1936. We figure to have our reservoir to the point of maximum depletion about the 15th to the 20th of March. That is before the snow starts seriously to melt. There are alternate thaws, but that is the serious break-up, about the middle of March. It varies possibly 2 weeks in the year. The flood season runs about the middle of March until the first of May, sometimes into May, but there is no uniformity in those floods.

"Q. No, that fortunately is true. Do you know what is the flood season on the Tennessee River?

A. Generally speaking I have studied the flood occurrence diagrams, and was surprised to find such similarity between the occurrence of floods on the Tennessee with the floods on the Hudson and Sacandaga, except your floods occur about two months earlier, in other words, your floods start about the middle of December and run to about the first of April.

[fol. 1069] Mr. R. T. Jackson: I move to strike out everything except the last sentence. I ask for definite information instead of which he proceeds with a speech of comparison.

Judge Allen: The answer may stand.

Mr. R. T. Jackson: May we have our exception, please?

Judge Allen: You may have your exception."

In my study of this problem, I have not familiarized myself with the statement of Mr. Lilienthal before the Committee of Congress on the Hearings on the First Deficiency Appropriation Bill, page 279, the table submitted by TVA which shows that this TVA Unified Plan is to be operated so as to produce 660,000 kilowatts of continuous firm power and 5,780,000,000 kilowatt hours of energy annually. In my direct examination I did not assume that this TVA Unified Plan including Norris Dam, was going to be operated so as to produce 660,000 kilowatts of firm capacity, 24 hours a day, and 5,780,000,000 kilowatt hours of firm energy annually, in the dryest years of record. In explaining that answer, my studies were directed entirely to satisfy myself that it was entirely feasible and practicable to operate Norris reservoir for the combined purposes of flood control and low water improvement without having in mind at all what that low water improvement would be applied to. I knew there would be some power development and navigation was to be assisted.

I do not know, in the low water years, such as 1925, how much tributary storage in acre feet would have to be provided in order to produce the 660,000 kilowatts of firm power, and the 5,780,000,000 kilowatt hours of firm energy. What I would say is that in the course of my studies, I included 1925. I took the ten year period, 1920 to 1930, which included two particularly dry years, a number of wet years and a number of years of what we might call semi-normal years over that period of ten years. At Clinch River dam site I took the weekly flows. From these weekly flows at the Clinch River dam site I computed what we call the mass curve, which is the custom to determine the proper storage to have on the stream, to determine the proper reservoir capacity. I say I did that over a period of ten years. Of course to determine the capacity accurately and definitely, you should use a longer period of time. But, I was merely satisfying myself that I had made sufficient study to know I could testify as I have. I have not calculated anything like this particular data.

I cannot tell you at what elevation Norris Dam would have to be, from my studies, in a dry year like 1925, on the first of February, or the first of April, in order to permit the production of that amount of firm capacity or firm power as previously stated.

Redirect examination:

I testified on direct examination that the principal feature distinguishing Norris Dam from the usual power dam was the unusually large sluiceways and the high flood gates. Frankly, I do not think I said anything about the flood gates, but I should have. I did say something about the hydraulic capacity. Neither the sluiceways nor flood gates of the type incorporated in Norris Dam have any usefulness for the production of power. The function of sluiceways is to get rid of the water when you don't want it in the reservoir. [fol. 1071] The spillway gates can take away only the water above the spillway crest, and not below.

"Q. All right. Mr. Jackson asked you as to how the benefits were assessed. Now, I will ask you as to what benefits were derived from the operation of your project in the flood of 1936?

Mr. R. T. Jackson: I object to that.

Mr. Fitts: The question was opened up by the complainants.

Mr. R. T. Jackson: Going into a different question, purely collateral.

Mr. Fitts: May I make one statement. The only purpose of asking that question, that he asked about the assessment of benefits was to attempt to show that this project was beneficial, 95 per cent of power, and this witness is prepared to testify the opposite is the truth. And I think we now have the right to show that. I do not think the complainants can open up a question like that on cross-examination.

Mr. R. T. Jackson: It is purely a collateral issue.

Judge Allen: Objection is overruled. He may answer.

Mr. R. T. Jackson: May we have our exception.

A. Might I see the hydrograph that was submitted?

Mr. Fly: Yes.

Mr. R. T. Jackson: Not unless our objection is overruled.

Judge Allen: He may testify to the facts. The hydrograph is still ruled out.

Mr. Fitts: We are not offering it.

The Witness: Not that one. The other one, sir.

Mr. R. T. Jackson: We object to the use of the exhibit which is excluded from the record, and gotten into the record in another way.

Judge Allen: Mr. Fitts, you are referring to the testimony brought out by Mr. Jackson as to the rate of assessment as to the benefits from flood control compared with the rate of assessment for benefits from power.

Mr. Fitts: And I now wish to show the actual benefits from the rate of assessment——

[fol. 1071-a] Mr. R. T. Jackson: I hardly think this witness can impeach the findings of New York State as to what the benefits were.

Mr. Fly: He testified those were not actual benefits.

Mr. R. T. Jackson: He explained that.

Mr. Fly: He went expressly into that point.

Judge Allen: The witness may refresh his memory, but he may not testify from the exhibit which has been rejected.

The Witness: If your Honor please, I don't need the exhibit. I thought I might better explain it. In the flood of March 1936——

Mr. R. T. Jackson: May I interpose the objection that it is now obvious that we are going to have a recital of the description of a flood?

Judge Allen: The Court considers Mr. Jackson that you brought out this question by your cross-examination, and that the Authority is entitled to go into the matter to the extent indicated.

[fol. 1072] Mr. R. T. Jackson: May we have our exception?

Judge Allen: You may have your exception."

The benefits were quite substantial. There were large benefits from the reduction of the flood at the City of Albany. The flood of March, 1936, was the greatest in the known history of the Hudson and Sacandaga rivers. The Hudson River would have risen about 4 feet higher than it actually rose had not all of the water of the Sacandaga River been impounded during that flood in the Sacandaga reservoir. It decreased the flood at Albany by approximately 50,000 cubic feet per second. In other words, the flood at Albany was about 180,000 cubic feet per second, and had not the Sacandaga reservoir been in operation it would have been approximately 230,000 cubic feet per second, and that difference in volume of flow caused a reduction at Albany of four feet, which, because of the particular geography at that point, means a great deal. That flood oc-

curred on March 18, 1936, so far as Sacandaga reservoir is concerned.

"Q. How much of the capacity of your reservoir did you use to control that flood?

Mr. R. T. Jackson: We note our exception to this inquiry into the collateral issues.

Judge Allen: He may answer.

Mr. R. T. Jackson: We except."

We used about 610,000 acre feet out of a total available capacity of 760,000. I may say that in my previous answer I was supposed to describe the benefits of the reservoir during the flood of 1936. I have only described some of them. It was certainly of large benefit to the cities in the vicinity [fol. 1073] of Albany.

Recross-examination:

The Sacandaga reservoir drainage area is not about 50 per cent of the drainage area above Albany. The drainage area is approximately 1 to 8. It is about 1040 square miles at the dam site and 8100 square miles at Albany.

This flood occurred March 18, 1936. That is just about the time we expected the flood season to come along and we had our reservoir very nearly empty. If we had had it full to supply any firm power contracts or for any other purpose, I could still have used it to reduce floods, but not as efficiently as I did use it. If it were full at the time of the flood, it would be not as effective as an empty reservoir, for flood control, but there is always storage above the spillway crest. We can store up to 7 or 8 feet above the spillway crest. I am talking about a form of valley storage which has been elevated to flow over the spillway crest. It is uncontrolled storage.

(The witness was excused.)

[fol. 1074] JAMES S. BOWMAN was called as a witness on behalf of the defendants and, having been first duly sworn, was examined and testified as follows:

Direct examination:

I am 48 years old, reside in Knoxville, and am a civil engineer. I graduated from the University of Iowa in 1913

and was in highway and drainage engineering work for about two years. From 1915 to 1918, inclusive, I was Assistant Engineer and Construction Engineer with the Miami Conservancy District, Dayton, Ohio. In 1919 I was Irrigation Engineer for the Estate of L. Z. Lister, of Clearmont, Wyoming. From the beginning of 1920 to the end of 1928, I was Hydraulic Engineer, later Supervising Engineer, for the Fargo Engineering Company of Jackson, Michigan, engaged in general hydraulic engineering practice. From the middle of 1928 to September, 1932, I was a member of Harza Engineering Company, Chicago, engaged in the general engineering practice, chiefly hydraulic engineering of various types. From September, 1932, until October, 1933, I was teaching hydraulic engineering in the University of Wisconsin, covering hydrology, elementary hydraulics, river engineering, hydro-electric engineering, hydraulic machinery. I came with the TVA in October, 1933, and am at present Head Project Planning Engineer.

The chart, (offered and received in evidence as Defendants' Exhibit 36) is entitled "Tennessee River Drainage Basin", and was prepared under my supervision and direction. The facts shown thereon are correct and accurate to my knowledge.

"Mr. Fitts: We offer the chart in evidence as Defendants' Exhibit No. 36.

Judge Allen: Any objection?

Mr. R. T. Jackson: Yes, if your Honor please, we object [fol. 1075] upon the ground that the—at least the sheet handed to me, if it is a copy, is misleading. It does not show Gilbertsville Dam.

Mr. Fitts: It does on the exhibit.

Mr. R. T. Jackson: Just a minute. It does not show any differentiation between Coulter Shoals Dam and Norris Dam, one of which is constructed and one not under construction. It does not show Fontana Dam at all, which was included in the recommended plan which was handed to the Court by counsel for the Authority the first day of the trial. And there are others I have not got time to mention. For all of which, I think it is incompetent.

Judge Allen: Do you think it prejudices the complainants?

Mr. R. T. Jackson: I do not know for what purpose it is offered, if your Honor please, but if it is offered as in any

way defining the construction program of the Tennessee Valley Authority, then I think it would be misleading and incompetent.

Judge Allen: I believe Gilbertsville is on the exhibit, but it is not taken.

Mr. Fly: Yes. I think your Honor, I think if we wanted to show the stage of each of those dams we could put 'Recommended' under Watts Bar and Coulter Shoals, or 'Appropriations made.'

Mr. R. T. Jackson: Is Gilbertsville down here?

Mr. Fly: Gilbertsville is shown.

Mr. R. T. Jackson: The name is, but not the place. And we object because it does not show—where is Fontana site, on the Little Tennessee?

Mr. Fly: Yes. But this does not purport to be what is covered in any particular document, as I understand.

Judge Allen: The Court sustains the objection to the exhibit in its present form. The differentiation should be shown by the defendants as well as by the complainants, and Fontana Dam should be shown, Fontana Dam site."

(At a later session of the trial, the following occurred:)

"Mr. Fly: We again present Defendants' Exhibit 36, on which we were criticized for not showing the state of construction of dams and so on—I think very properly so. Under Guntersville Dam it is noted, 'Authorized for construction':

[fol. 1076] Pickwick, 'Under construction;' Wheeler, 'Completed;' Guntersville Dam 'Under Construction;' Chickamauga Dam 'Under construction;' Watts Bar Dam, 'Authorized for investigation;' Coulter Shoals Dam, 'Authorized for investigation;' Norris Dam, 'Completed;' Hiwassee Dam, 'Under construction;' and there is a symbol with each one showing the dams constructed, under construction dams for which appropriations for construction have been made, dams for which appropriations for investigation have been made. Then the further note to this effect, 'Project for Fontana Dam site, located on Little Tennessee River, recommended by TVA but no appropriations have been made.'

Mr. S. D. L. Jackson: If it please the Court it seems to me the direction of the Court was that they should show this Fontana Dam site on exhibit 36.

Judge Allen: We do not remember that we directed that Fontana Dam site be indicated on this map. The Court has felt, Mr. Jackson, that both litigants should be entitled to present their respective views in their maps. That is to say, although the colors were not very distinguishable we allowed you to indicate your views of the connections between various lines that really did not belong to the TVA and TVA by colors. Now, this is not misleading in the view of the Court, because in the legend it states the facts with reference to Fontana and you do not dispute those facts, do you?

Mr. S. D. L. Jackson: Do you mean no appropriations have yet been made?

Judge Allen: No appropriations have yet been made. Have appropriations been made.

Mr. S. D. L. Jackson: They do not have to be. All appropriations are authorized in the Act.

Judge Allen: Have appropriations been made for Fontana?

Mr. Fly: No, your Honor.

Judge Allen: I am asking Mr. Jackson.

Mr. S. D. L. Jackson: They have spent money investigating. I suppose they appropriated the money for that purpose, in view of that.

Judge Allen: We think we understand the facts with reference to Fontana. We think the Defendants are entitled to put in their map essentially as they have, so long as it is not misrepresented. We think they are entitled to put in their map their views, the same as you.

[fol. 1077] Judge Martin: We understand your general argument is that money from their general fund might be used for this dam, and this map shows there is no appropriation. Is not that the fact, as Judge Allen has just elicited?

Mr. S. D. L. Jackson: Also, here is a map that purports to show what TVA is doing. Now, TVA has not only once, but repeatedly recommended to Congress, and did it very recently, indicating their full intention to go ahead and construct Fontana Dam.

Judge Allen: Of course, the Court cannot assume that all of the things that the TVA might like to do will be done without an appropriation and authorization by Congress. We understand the facts set forth, and we overrule your objection to this map and it may be received in evidence.

We think that the legend is not misleading, states the facts. You do not dispute, as we understand your objection, that it goes to the weight and not to the competency of the map. There are maps in evidence which show Fontana Dam on the map, although no appropriation has been made for the construction.

Mr. S. D. L. Jackson: May we have an exception. I do state that this copy, the legend which shows, 'Was recommended,' the fact is that it is now, presently recommended. It is not in the past tense.

Judge Allen: When was it recommended, what was the date of the last recommendation?

Mr. S. D. L. Jackson: A week ago, day before yesterday.

Judge Allen: Ah right, that is past for today, that is a week ago.

Mr. S. D. L. Jackson: It is now pending before the Appropriations Committee.

Judge Allen: The map may be received in evidence. Your objection goes to the weight and not to the competency."

The white area shows the drainage basin of the Tennessee River, rising in Virginia and discharging into the Ohio at Paducah, Kentucky. The drainage basin has a total area of about 40,600 square miles, of which approximately half is above Chattanooga, and the narrow section through here by Chattanooga divides the drainage basin into two portions of about equal area.

[fol. 1078] Starting from the mouth we have first the Gilbertsville Dam site, which will create a reservoir extending to the Pickwick Landing Dam, which is now constructed. The principal tributary entering this reach of the river is the Duck River. The Pickwick Landing Dam will create a pool up to Wilson Dam, and for navigation purposes to the entrance of Lock No. 1 which is at the end of the Florence Canal. That is a canal about two and a half miles long leading from Wilson Dam down to Florence, and navigation passes through that canal instead of right up to the lock at Wilson. Wilson Dam, which has been constructed for quite a number of years, backs up to the Joe Wheeler Dam, 15½ miles. In the Wheeler pool the principal tributary is the Elk River, a short distance upstream from the dam. The Wheeler Dam backs up to Guntersville Dam near the town of Guntersville, Alabama. The Guntersville Dam is now under construction. The Wheeler pool is about 74

miles. There are no tributaries of any particular size in that reach of the river. The Guntersville Dam will back up to the present Hales Bar Dam, a distance of about 82 miles. Below the Hales Bar Dam is the present navigation dam known as Widows Bar, which will be submerged, and which will be removed so as not to create a submerged obstruction to navigation. The Hales Bar Dam makes the link between Hales Bar and the Chickamauga Dam which is located about seven miles upstream from Chattanooga. Chickamauga Dam will back about 59 miles to the Watts Bar Dam site. The principal tributary entering in the Chickamauga pool is the Hiwassee River. Chickamauga Dam is now under construction. I would think that it is something over 50 per cent completed, just as a rough statement. The Watts Bar Dam backs 74 miles to the Coulter Shoals Dam site, and in the pool of the Watts Bar Dam we have the Clinch River and the Little Tennessee River, the [fol. 1079] principal tributaries entering in this pool. The Coulter Shoals Dam site is located a short distance upstream from the confluence of the Little Tennessee. Coulter Shoals Dam will back to Knoxville and the confluence of the Holston and French Broad Rivers. At Watts Bar and Coulter Shoals preliminary investigations have been going on for some time, and some expenditures have been made on those sites, but no construction has been undertaken of any sort. That completes the description of the exhibit.

Gilbertsville Dam is in the same status as Watts Bar and Coulter Shoals. A considerable sum has been spent for investigation of the site, but no actual construction has been made. The Fontana Dam site is located on the Little Tennessee River some distance upstream from the confluence of the Cheoah River and upstream from the present Cheoah plant of the Aluminum Company. Some investigations, very rough, were made in 1936, and in the House Deficiency Appropriation Hearings of 1936, the Board requested that funds be allocated to Fontana so that investigation and construction could be carried on at that site instead of at the Hiwassee site, on which investigations had already been started. Since that time we have been doing no work on the Fontana site.

I have omitted mentioning the Norris and Hiwassee Dams here. The Norris Dam is located on the Clinch River, a short distance below the junction of the Powell and the

Clinch, and the Hiwassee Dam is on the Hiwassee River about 14 miles below the town of Murphy and 11 miles above the state line in North Carolina. Norris Dam has been completed and is in operation. At Hiwassee Dam construction has been under way for some time, but the funds which have been expended are rather small. The construction camp [fol. 1080] has been built, the access road is completed, and excavation and erection of construction equipment has been going on for some time.

The photograph (offered and received in evidence as Defendants' Exhibit 37) was prepared under my supervision and direction. I asked that it be prepared and am acquainted with its preparation. I didn't take the photograph. As far as a sort of composite photograph goes, it actually represents what it is purported to represent. It is not an actual photograph of any actual dam, but it is a photograph of a model, with the surrounding countryside superimposed. The model that was photographed is out at Chickamauga Dam. It is a photograph of a scale model of the Chickamauga Dam and is prepared for the purpose of giving a visual picture of what the structure looked like, so far as we are able to give it. By composite picture I mean that that exhibit is taken from the photograph of the countryside and the photograph of the dam was taken from another. It depicts the carrying out of the actual plan for Chickamauga.

"Mr. Fitts: We offer this exhibit in evidence as Defendants' Exhibit No. 37.

Mr. R. T. Jackson: We object to it because it appears it is merely a drawing of some character that is superimposed upon pictures of the countryside, and it is incompetent for any purpose.

Judge Allen: Objection overruled. It will be admitted.

Mr. R. T. Jackson: May we have an exception?

Judge Allen: You may have your exception."

In the center of the picture is the reservoir or pool above the dam; toward the left of the picture being the upstream direction, and toward the right of the picture being the [fol. 1081] downstream direction. In the right center is the water below the dam, showing the tail water, in engineering parlance. The alignment of the dam extends from the bluff in the upper righthand corner and across to the

left. In the immediate foreground on the left is a part of the embankment that extends out at a sort of obtuse angle upstream, and ties to the bluff on the righthand side of the river going down stream.

In the immediate foreground is the navigation lock, showing on the upstream side what we call the upper gates, and on the downstream side what we call the lower gates. Between these two gates is what is referred to as the lock chamber. There is a little structure on the river wall of the lock which is simply the operating house, for operating the gates and valves in the lock. Going onto the righthand side of the picture we come to the spillway in which a number of piers are shown, and there is a spillway gate which you can see between every one of those piers. There is a little detail in a circle, which shows the masonry crest of the spillway and the gate above that. That is abutting on one pier, the nearest pier being removed for convenience of illustration. Above that is the runway with the crane for operating the spillway gates. In this little illustration there is a cross hatched section showing the pool level, about up to the crest of the gate in the cut. Going onto the righthand side of the picture, the power house is shown in the illustration, and on beyond that, very faintly, the substation and the tie into the embankment of the bluff on the far side of the river.

The size of the lock at Chickamauga is 60 feet wide and 360 feet long in the clear. That is, the gates can swing when there is a tow or other equipment inside of the lock chamber of 360 feet. The usable length is 360 feet; that is, at least, what the Army Engineers call the clear dimensions [fol. 1082] of the lock. You will notice the upstream wall on the river side of the lock is extended a considerable distance upstream. That is a guard wall to prevent the velocity through the spillway from catching a boat near the spillway and sweeping it downstream into the spillway. It is a guard rail which extends upstream far enough so that there is a sufficient depth and the velocity of the river is relatively small.

The chart of Gilbertsville Dam (offered and received in evidence as Defendants' Exhibit 38) was prepared under my supervision and direction. The facts shown thereon are correct to the best of my knowledge. This chart on the left hand side represents the reach of the river between

Gilbertsville and Pickwick Landing. That is taken from detailed surveys of that stretch of the river. In the lower central portion is the map of the Tennessee Valley, showing the location of the Gilbertsville Dam site. The large illustration to the right hand side shows in general the arrangement of the dam and the relation of the various pool levels.

Cross-examination:

This exhibit sets forth an approximate plan for the Gilbertsville Dam. The Gilbertsville Dam is still in the preliminary design stage, and no detailed design has been made. This is approximately about the best that can be shown now. I can not say whether the Board of Directors of the TVA has or has not adopted a plan or any plan which is shown on this Exhibit 38. Referring to the two elevations on the right hand side, one with the words "flood surcharge," I can not say whether or not the Board of Directors of the TVA has set those elevations for the Gilbertsville pool. This exhibit shows no power elevation, or power storage; there is nothing indicated there distinctly [fol. 1083] for that purpose. It does not show that any storage can be used for power but it does not show that it can not. There is some storage that could be used for that purpose. That is not storage below 350 which could be used for power. 350 is the lowest elevation to which the pool can be drawn at the dam during the usual winter conditions and at the same time maintain navigation to Pickwick. That is the minimum level. In other words when I say a part of the storage could be used for power, I refer to what I have marked "flood surcharge," some of the surcharge within that volume could be used for power. That is, it would be possible to operate it so that a maximum pool level might be set in between the elevation 350 and 375 and an area for power use defined there. I know of no resolution of the Board of Directors of the TVA either setting apart some of that area, or declining to do so. This is just a cross section of the spillway and does not show any power house. To the best of my knowledge it is a reduction of the actual reservoir map. I think the widths of the proposed pool in proportion to the map are exaggerated. We could hardly have shown a pool of this length. It would simply have been a line.

Direct examination continued:

This is a chart of the spillway section and it represents the present proposed design of that section, that is, the status to date of the preliminary design. That is a fair representation. The making of these designs comes as a matter of course under the duties allocated to my division, to prepare these preliminary designs. They were not prepared by me, but under my supervision. That is a part of my general duties and my position.

“Mr. R. T. Jackson: We object to the map * * * because it represents no authoritative action of the Tennessee Valley Authority according to the testimony of this witness.

Mr. Fitts: It is not offered as such.

[fol. 1084] Mr. R. T. Jackson: Just a minute. And every time that we have made any inquiry it has been stated none of these employees of the Tennessee Valley Authority could bind the Authority in any manner, shape or form, no definite action could be shown in that way, and it seems to me quite obvious if it cannot be shown as an admission, it cannot be shown by way of self serving declarations.

Mr. Fly: Mr. Bowman, Mr. Jackson asked you if some of the waters that might be in the flood surcharge could be used for power. I ask you, could part of the water in the navigation pool as you have outlined it there, be used for power?

The Witness: Yes, that is correct.

By Mr. Fitts:

Q. You could use any part of it if you wanted to?

A. You could use any part of it if you wanted to.

Judge Allen: The objection is overruled. The Court considers that the objection goes to the weight and not to the competency. It may be received and you may have your exception.

Mr. R. T. Jackson: Might I state the basis of the facts? My point is this. My understanding from the testimony of Dr. Morgan is that these elevations were 353 and 357. That is in the exhibit 328, the report on the unified plan, and similar figures in the testimony of Dr. Morgan in the report to Congress, that is here in evidence. And these reports show the installation of power facilities, according to the tables submitted to the Congress in exhibit 115; I think also

in exhibit 116 that is shown. My point was that if this exhibit should go into the record then the Supreme Court or anyone reviewing this case would be justified in assuming that those were the authoritative determinations of the levels for that.

Judge Allen: The objection is overruled. You may have your exception.

Mr. R. T. Jackson: Exception please."

The Gilbertsville Dam site is located near the town of Gilbertsville, Kentucky, about 22.7 miles above the mouth of the Tennessee River at Paducah. The Ohio River is canalized, Dam No. 52 being downstream from Paducah. This backs the water up the Tennessee for a distance of about 40 miles, and creates a navigable depth somewhat in excess of 9 feet up to the Gilbertsville site. When the dam is constructed the length of the reservoir will be 184 miles, reaching to the Pickwick Landing Dam.

[fol. 1085] The navigation pool as shown on this drawing at elevation 350 is the elevation at the dam which must be maintained during the season of high or good water flow in the Tennessee River in order to create a navigable depth of 9 feet at the entrance to Pickwick Landing lock. The flood surcharge elevation 375, is the top of flood surcharge shown on this exhibit. The flood surcharge depth is the difference between the elevation 375, top of the flood surcharge, which is the top of the spillway gates, and elevation 350, which is the top of the navigation pool. That is what we designate the flood surcharge, or the controlled flood surcharge. That depth is entirely behind the gates and can be cut off with the gates. This is the fixed masonry crest of the spillway at this point. The spillway gate reaches from that point up to this elevation 375, when the gate is resting on the crest of the spillway. The height of the gates at the Gilbertsville Dam will be 45 feet, that is, the fixed masonry crest will be at elevation 330. Since these gates can be raised during flood time, that is, in case of maintaining this pool level at this point to discharge floods, the dead storage would be in terms of this, the storage below the fixed crest of the spillway. That is also part of the storage that is necessary to create the navigation depth, but not enough for that.

There will be times in times of high flood when it will be possible to lower the reservoir below 350 and still have the

navigation depth up to Pickwick. That could be done in advance of a flood. If you saw that there was opportunity to release some of the water in this reservoir, it could be drawn down below that on account of the low elevation of the spillway crest.

The table (offered and received in evidence as Defendants' Exhibit 39) was prepared by me, and it correctly represents the statistical information that appears thereon. If it is not adopted by the Board, then the words "tentative, not adopted," which we have written in, are correct, and it is tentative in the minds of those who are in charge of the preliminary design, but at the present time it represents our best engineering judgment as to what should be built there.

"Mr. Fitts: We offer this table in evidence as defendants' exhibit No. 39, simply as the easy way of showing the present judgment of those who are in charge of designing the project, as to what will be its physical characteristics and design.

Mr. R. T. Jackson: We object to this exhibit upon the ground that the only adopted and authorized project for Gilbertsville reported to the Congress and in the exhibits here in evidence shows for instance the total reservoir volume of 4,850,000 acre feet, and this, like the one before, has not been adopted by the Board of the Tennessee Valley Authority, has no official standing or status whatsoever, and if we are to have a gentleman come in here and simply say here is something that could be done and offer it, and it is received in evidence, then I think it is impossible to reach any conclusion about the projects whatsoever. Furthermore, I think it would be grossly misleading in this case, as in the previous one, to have this go in, even if tentative and not adopted. It has not been authorized by the Tennessee Valley Authority Board, it has no standing whatsoever, and yet it goes in here as purporting to in some way represent what the Gilbertsville project is. It is grossly misleading to any Court.

Mr. Fitts: If it doesn't go in, it simply means we have to take each one of those figures and ask the witness about them, and I think we have a perfect right to do it, ask him as to what the present judgment of the engineers in charge of the planning of this project is, as to what those figures represent.

Judge Allen: The objection is overruled. The Court thinks it goes to the weight and not to the competency. The Court considers that the complainants based their case partly on what could be done. That is, Gilbertsville is included as one of the main elements in the case of the complainants. Subject to the objection for weight, the Court considers this competent. You can have your exception.

Mr. R. T. Jackson: May we have it noted, please? I don't want us to misstate our position about it, because of course we have based our case upon what the Board of the Tennessee Valley Authority has officially reported to the Congress. And I think we are entitled to rely upon the integrity of that report.

[fol. 1087] Mr. Fly: I know the Court has already ruled, and I think properly. But of course, in projecting a project either at Fontana or at Gilbertsville or at Watts Bar when the Board two or three years ago expressed some sort of judgment as to what would be done there, of course, the Board had not adopted a design. Of course, the Board has never adopted a design for either of those dams. And it simply gave some sort of an estimate about what might be done. Now, this witness is simply trying to give the status of the project as best he can in its present tentative condition.

Mr. R. T. Jackson: Of course, if the Board has changed its position since it reported officially to Congress there must be Board action to show that.

Judge Allen: The Court overrules the objection and the Court bears in mind that complainants time and again have said that they relied upon anticipatory injuries. All that part of the complainants' case which is based upon Gilbertsville, which certainly is a large part of its case, would seem to be to a considerable extent anticipatory. Now, subject to the objection to the weight the Court considers that this evidence is admissible.

Mr. R. T. Jackson: May I point out we are only seeking anticipatory relief against what the Tennessee Valley Authority threatens to do, and not against the engineering concept or imagination of Mr. Bowman, for whom I have the highest regard, both for his ability and his resourcefulness."

The chart (offered and received in evidence as Defendants' Exhibit 40) was prepared under my supervision and di-

rection and correctly represents the facts as they appear thereon, with the exception that the width scale of the river is somewhat exaggerated in order to really show the picture. Wheeler Dam has been constructed, and Pickwick is practically complete.

Cross-examination:

I could not say of my own knowledge whether the elevations shown on Exhibit 40 have been fixed by any resolutions of the Board of Directors of TVA. I do not have knowledge of a Board resolution on that subject.

"Mr. R. T. Jackson: We object as to exhibit 40 upon the ground it is incompetent, because it purports to set forth [fol. 1088] data and determinations of the Tennessee Valley Authority which, so far as the record is concerned, have never been made. And upon the further ground, to have such an exhibit in the record, in such situation, would be grossly misleading to the Court."

Examination by the Court:

It is practical to operate these dams at the level shown on the exhibit.

Direct examination continued:

It represents the elevation at which Wheeler is being operated.

"Mr. Fitts: And, may it please the Court, this subject of the operating levels being set by board resolutions has been raised two or three times here, and in order to clarify that situation I would like to offer in evidence as defendants' Exhibit No. 41, the resolution of the Board of Directors, creating the water control planning department of the Authority, and outlining the duties of the Chief Water Control Planning Engineer in the setting of these levels and the operation of these pools, and Mr. Woodward is the head of that department, and will testify following Mr. Bowman.

Judge Allen: Any objections?

Mr. R. T. Jackson: I have not seen them, your Honor. We tried to get to see these resolutions before. We object to this exhibit because we would like to have the whole minutes if they are going to be offered in evidence.

Judge Allen: Just a minute. Your objection, Mr. Jackson, I would gather runs to this being received as an exhibit?

Mr. R. T. Jackson: Runs to it being received as an exhibit, as an excerpt from the minutes, without the minutes being produced so we may see whether there is anything else which ought to go with it, to make it complete."

(Thereupon, counsel for defendants read to the Court the exhibit stating that it was certified by Charles E. Hoffman under the seal of TVA and that the TVA statute provides that the seal of TVA shall be noticed in judicial proceedings.)

[fol. 1089] "Judge Allen: Is there any question as to authenticity?

Mr. R. T. Jackson: Not as to what is here, your Honor. I think there is a question as to whether it is a complete excerpt from the minutes.

Judge Allen: Specifically, do you question its authenticity?

Mr. R. T. Jackson: I do not question its authenticity. If Mr. Fitts tells me it is true we know that is so.

Judge Allen: If you do question the authenticity, we will have the witness to prove that.

Mr. Fitts: It is the entire resolution on that subject.

Mr. R. T. Jackson: How is that?

Mr. Fitts: It is the entire resolution on that subject, creating the position.

Mr. R. T. Jackson: We object unless we have a chance to see the whole minutes.

Judge Allen: The objection is overruled, and the exhibit may be received.

Mr. R. T. Jackson: We may have our exception, I assume. And, now are you through in connection with defendants' exhibit 40?

Mr. Fitts: I am not through, I don't think, no.

Mr. R. T. Jackson: The point I want to make with the reception of exhibit 41, I think raises additional grounds of objection to exhibit 40, in that it has nothing to show that exhibit 40 has in any way been approved by the Chief Engineer, much less by the Board of Directors of the Tennessee Valley Authority, and the gentleman on the stand is not even the head of the so-called water control Planning Division. Under those circumstances I think those are further objections to its receipt.

Judge Martin: Are you chief water control planning engineer?

The Witness: No, sir; I am not. Mr. Woodward is.

Judge Martin: What is your official position?

The Witness: Head project planning engineer.

Mr. R. T. Jackson: The objection on the additional ground is overruled, is that right?

[fol. 1090] Judge Allen: The exhibit is received. I do not understand the other exhibit has yet been offered.

Mr. Fitts: Exhibit 40 was offered and received.

Mr. R. T. Jackson: I conceive this resolution is additional grounds upon which I wish to make my objection. I am merely trying to get the record straight. If they are overruled, may I have exception?

Judge Allen: The Court wishes to state that since the hypothetical evidence was received, the Court overrules the objection, but not waiving the competency, do you feel that your objection here should be waived and that these exhibits are admissible upon the ground that they show the present status of the work as detailed.

Mr. R. T. Jackson: May we have our exception?"

With reference to Defendants' Exhibit 40, starting at the down-stream end of this reach of the river is Pickwick Landing. The smaller chart in the upper left-hand corner shown in red is the stretch of river between Pickwick Landing Dam and Guntersville. Pickwick Landing is a short distance down-stream from the Mississippi-Tennessee state line. This dam backs up to Lock and Dam No. 1 at the end of the Florence Canal immediately below Wilson Dam for navigation. The pool itself goes back clear up to Wilson Dam. The upper diagram on the right-hand side of the chart is a cross section of Pickwick Landing pool.

In the background is the pier of the dam—those piers being spaced about 40 foot centers in the clear, with a runway from the top of the piers. There is also a part of the diagram shown by stippling, which is a cross section of the dam itself and apron, and superimposed upon that are the spillway gates. The drawing indicates three dimensions on the single section. You have a cross section of the crest, the gates, the aprons and the runway, and the pier is in the background, possibly 40 feet in the back. The top of the gates, when the gates are resting on the spillway at elevation 418, at top of the spillway level, the gates at Pickwick

[fol. 1091] are 40 feet high, making the crest at 378 feet. The navigation level in this case is 408, that is the top of the navigation pool which is required to reach Lock and Dam No. 1. The difference between elevation 408 and 418, a depth of 10 feet, is what we refer to as the flood control storage.

“Q. Mr. Bowman, right there I would like to ask you whether in your opinion it is practicable and reasonable, and proper to operate the dam as shown for navigation, flood control and production of power—

Mr. R. T. Jackson: I object to the competency of the witness to testify as to navigation.

Mr. Fitts: Do you want me to qualify him further? I think he is qualified.

Mr. R. T. Jackson: He can testify as to anything that involves simply a question of hydraulics, in regard to depths, things of that character. But I think the witness has not qualified to testify in regard to navigation.

Mr. Fitts: I am asking him to testify as to the operation of the dam.

Mr. R. T. Jackson: For navigation. I do not understand he can qualify as to that.

Judge Allen: Can this witness answer with reference to the creation of a channel of nine feet or more?

Mr. Fitts: I suppose he can.

The Witness: I can testify of my own knowledge that at this elevation of 408, it will create a navigable depth to Lock No. 1.

Mr. Fitts: By nine feet, you mean over that, to take care of the draft.

The Witness: It will take a nine foot draft.

Judge Allen: Objection overruled. The witness may answer. The objection is overruled, Mr. Fly. The witness may answer. The Court certainly knows by this time that the depth of nine feet has some relation to navigation.

Mr. R. T. Jackson: The witness can testify as to depth, but the question is, he has not qualified to testify for navigation.

Mr. Fitts: At the levels as shown by you?

The Witness: Yes.”

[fol. 1092] The Wheeler Dam, the lower one on these cross sections, shows the cross section of the Wheeler Dam in the

same detail as I have explained for Pickwick, Wheeler Dam being located $15\frac{1}{2}$ miles upstream from Wilson, creating a reservoir of 74.1 miles long up to the point at which Guntersville Dam is being constructed. This cross section shows the top of the spillway gates at elevation 556, which is the top of the flood surcharge. The top of the navigation pool is at elevation 548, which is an elevation which will furnish a navigable depth into the Guntersville Lock at the time the flow in the river creates a small backwater effect. The difference between elevation 556 and 548, which is 8 feet, we designate as the depth of controlled flood surcharge. Wheeler Dam is actually being operated at the levels which I show.

The type of the gate on Wheeler is a somewhat different principle than the type of gate at Pickwick and the type proposed for Gilbertsville, Guntersville and Chickamauga. They are simply large vertical leaf gates 40 feet wide, like the sliding trap door in a rabbit trap. They elevate above the spillway and lower. At Wheeler, however, we have what is known as the radial or Taintor gate. We have an upstream section which is shown by the circle, which is supported in this manner, to the piers, being fastened by structural steel arms, which meet in a pin at this point, and the gate is simply revolved upward on this pin as a center, to operate it from the points above the top of the gate.

"Q. Mr. Bowman, I will ask you whether in your opinion it is reasonable and practicable to operate Wheeler Dam at the levels as shown on defendants' exhibit No. 40 for the combined purposes of navigation, flood control and the production of power?

Mr. R. T. Jackson: I object to the competency of the witness to answer the question so far as it involves the operation for navigation purposes.

Judge Allen: He may answer.

Mr. Jackson: May we have our exception?

A. I will say that is my opinion, also it has been operated in that manner for something over a year, I believe."

[fol. 1093] Apart from the foundations, and probably more difficult construction program on account of depth of water and depth of foundation, Gilbertsville provides for a surcharge of 25 feet, while considerably less surcharge is

provided for the other dams. There is considerably more flood surcharge storage provided at Gilbertsville than at Pickwick and Wheeler, on account of the depth of the surcharge as well as the length, which is 3 times as long as the other pools will average.

The table (offered and received in evidence as Defendants' Exhibit 42) contains statistical information with respect to the Pickwick project which I prepared. The information is correct. It represents the actual figures with respect to the Pickwick project, not an estimate.

"Mr. Fitts: We offer this table in evidence as defendants' exhibit No. 42.

Mr. R. T. Jackson: We object to the table upon the ground that the figures that are shown on the exhibit depend upon what elevation, and matters of that character that should have been fixed authoritatively by the Board of the Tennessee Valley Authority, and there is no proof whatever that the Board has fixed any figures for the elevations of the pools, and other matter shown therein.

Judge Allen: Objection overruled.

Mr. R. T. Jackson: Exception.

Judge Allen: It will be received."

The table (offered and received in evidence as Defendants' Exhibit 43) contains statistical information as to the Wheeler project which I have prepared. The information is correct. It represents actual figures.

"Mr. Fitts: We offer this table in evidence as Defendants' Exhibit No. 43.

Mr. R. T. Jackson: We object upon the same ground, that is that there is no showing that the elevations have ever been fixed by the Board, or if they have been that they are the same as shown by the witness. There is no showing in [fol. 1094] reference to authorization which the witness purports to show in the table in regard to generating units, or anything of that character, and it is utterly incompetent.

Judge Allen: The objection is overruled. You may have your exception.

Mr. R. T. Jackson: Exception noted, please."

The difference in the figures shown on Defendants' Exhibit 43 for flood surcharge storage of 440,000 acre feet at Wheeler and the figures contained in Complainants' Ex-

hibit 116, which is a table printed in the Hearings on the Second Deficiency Appropriations Act of 1937, arises from the fact that those figures in the Deficiency Appropriations Act were based on what we call flat pool level. That is elevation 550 for the navigation pool, which is the elevation required at the entrance of the Guntersville Lock, extended down-stream to Wheeler as a flat plane, assuming no flow in the river. The figures on this exhibit are based on the fact that from elevation 550 at Guntersville during the winter and spring season there will be a back-water slope down-stream, which, under ordinary conditions, will mean an elevation of about 548 at the dam. Likewise, at the top of the surcharge there would be a backwater slope which would be parallel, and we have taken the difference between those two planes, using 548 as the lower plane instead of 550.

“Q. Well, are you satisfied that under normal conditions you can operate at the level of 548 and still maintain your navigation channel?

A. Yes, sir.

Mr. R. T. Jackson: Just a moment. I object to the competency of the witness to answer that question.

Judge Allen: Overruled.

Mr. R. T. Jackson: Exception noted, please.”

[fol. 1095] Examination by the Court:

Wheeler Dam is in operation; I think it has been in operation for just about a year. The figures are based upon my knowledge of the operation. I have examined the records of pool levels and know that the pool levels had actually fluctuated between those limits in the past year.

Direct examination continued:

Referring back to Defendants' Exhibits 38 and 39, the amount of storage below elevation 350 appears to be greatly in excess of the amount above elevation 350, but that does not correctly show the comparative amounts of storage. Of course immediately above the dam those relative depths are such that it would give the appearance of the volume below 350 being much greater than the volume above. This is not the actual case because in this drawing we could not extend the water above the dam on to the upper end of the

reservoir. The lower portion is in the bottom of the valley where the width is less than at the top. Up at Pickwick Dam, elevation 350 is practically coincident with low water elevation. That lower portion marked "navigation pool," considering it longitudinally of the river, is a triangle which is largely located inside the river banks, except down at the lower end where it is inside of the second banks, while the volume above 350 is of course at the top of the pool and remains that depth on up through the pool, and laterally is spread out for the full width of the valley at that elevation, and into the embayments of the tributaries. The difference in those volumes is brought about in Exhibit 39 in which it shows that the volume of the reservoir at navigation level, at elevation 350, taking it on a flat plane basis, is 1,550,000 acre feet, while in line 9 the controlling flood surcharge—that is, the volume between elevation 350 and 375—is 4,600,000 acre feet, or very close to 3 times.

[fol. 1096] The chart (offered and received in evidence as Defendants' Exhibit 44) was prepared under my supervision and direction, and the facts or estimates that are shown thereon are correct and accurate to my best knowledge. Both Guntersville and Chickamauga Dams are in process of construction and probably are something more than 50 per cent completed, and the cross-sections of the dams as shown are truly representative of the way the spillways are being constructed. The surcharge pool level is fixed physically by the top of the gates, and the gates are being manufactured. I think some of the spillway crest is in, so that level is definitely fixed physically. The top of the navigation pool is physically fixed by the elevation required, in the case of Guntersville to back up to the lock at Hales Bar; and in the case of Chickamauga by the depth required or the elevation required to create a navigable depth at the Watts Bar Dam site, which has now been definitely selected as the next site above Chickamauga.

"Mr. Fitts: We offer in evidence defendants' Exhibit 44.

Mr. R. T. Jackson: We object to the exhibit upon the ground that there is no proof that the elevations shown upon the exhibit have ever been authorized by the Tennessee Valley Authority; on the ground that they are contradicted by other exhibits already in the record, which represent the authoritative action of the Tennessee Valley Authority by its board of directors.

Judge Allen: According to the plans of these dams which are now partly constructed, could they be operated at the levels set out in this exhibit?

The Witness: Yes, they can, your Honor.

Judge Allen: The objection is overruled. You may proceed.

Mr. R. T. Jackson: May we have our exception?

Judge Allen: Yes."

Beginning with the Guntersville Dam, which is at the down-stream end of the reach of the river shown, and which [fol. 1097] is the next dam above Wheeler, which was explained on the previous chart, Guntersville Dam will back water 82.1 miles up to the existing Hales Bar Dam. The cross section of the Guntersville spillway is shown in this water cross section on the left-hand side of the chart. The gates on the spillway in this case will be the flat vertical lift gates, to which I previously referred, 40 feet in height by 40 feet wide. The top of these gates will be at elevation 585, which we have designated as the top of the flood surcharge. The top of the navigation pool shown as elevation 591 is the elevation required to create a 9-foot navigable depth back to the Hales Bar Dam at time of flow in the river which will cause slight back-water effect.

Examination by the Court:

Hales Bar Dam is a dam owned by The Tennessee Electric Power Company, and Guntersville will simply back up to the Hales Bar Dam, at which there is an existing navigation lock. It is somewhat smaller than the locks which are being installed at the present time for Wheeler and Guntersville, but it is perfectly usable at present, and Hales Bar in turn will back the water to a depth of 9 feet into the Chattanooga Harbor. The operation of Hales Bar Dam will not be interfered with at all, except that, with a chain of dams, the conditions after you have built that chain are never quite the same as they were before. The stretch of the river will be affected to some extent, but Hales Bar will still be there in operating condition. Some dredging will be required from Chattanooga to the Chickamauga Dam in order to obtain a 9-foot navigable depth in Hales Bar pool. That fixes a tie then between the Guntersville Dam which is being constructed by the TVA and the Chickamauga Dam. I believe that Hales Bar will be benefited really by the de-

[fol. 1098] velopment of the river under the Unified Plan on account of the release in low water season from Norris Dam and the other dams on the main river upstream, that is, the dependable flow at Hales Bar Dam can be materially increased.

Direct examination continued:

Hales Bar Dam, without some additional work, is not quite sufficient to give a navigable channel all the way back to the Chickamauga pool. We can not get the full 9-foot navigable depth under low water conditions. By increasing the low water flow in the river in the low water seasons, the amount of firm power that can be generated at Hales Bar will be increased. Of course the firm power generated at Hales Bar Dam itself, I believe, is a high-water condition rather than a low-water condition, but the amount of firm power, if you want to call the summer firm power, will be increased.

The cross section of Chickamauga is shown by the upper one of these two cross sections. The minimum navigation pool level is shown as elevation 673.5, which level will be sufficient to create a minimum 9-foot navigable depth upstream to the Watts Bar Dam site, a distance of approximately 59 miles, when a slight backwater effect is existing during the ordinary flow in the winter and spring. The surcharge elevation at Chickamauga Dam is fixed by the top of the spillway gates, which is elevation 685, the difference between these two elevations of 11.5 feet being the depth of the controlled flood surcharge. The location of the pools of these two dams is shown in general on the small photographic print in red. The same general explanation as to principles and the size of the navigation pools and capacities as compared with the storage for that navigation pool that I made with respect to the Gilbertsville Dam, [fol. 1099] applies in a lesser degree, but in the same principles, to all the other dams that are shown. The relative depths that are shown in the charts are no representation of the pool's volume as a whole.

The table (offered and received in evidence as Defendant's Exhibit 45) contains statistical figures on the Guntersville project, which table was prepared by me and which accurately represents the information that is shown there.

These figures are based on the actual design of the Gunter-ville Dam as it is being constructed.

"Mr. Fitts: We offer the table in evidence as Defendants' Exhibit 45.

Mr. R. T. Jackson: I object on the ground it shows information which could only be authoritatively shown by resolutions of the Board of Directors of the Tennessee Valley Authority and cannot be shown by some employee expressing his ideas.

Judge Allen: Objection overruled. It will be received.

Mr. R. T. Jackson: Exception."

The table (offered and received in evidence as Defendants' Exhibit 46) contains certain statistical information with respect to the Chickamauga project which was prepared by me. The information contained in it is accurate and correct. The figures are based upon the design of the Chickamauga Dam, upon which the dam is actually being constructed.

"Mr. Fitts: We offer the table just referred to as Defendants' Exhibit 46.

Mr. R. T. Jackson: We object to the exhibit on the ground there is not only no proof that this is the design used for the construction of Chickamauga project, which has been approved by the Board of Directors of the Tennessee Valley Authority, but in fact the evidence before the Court shows that the action is in conflict with what the witness stated, and upon the ground it only shows the hopes, plans, desires and wishes of this witness, of policies as to how this particular dam should be operated, and are irrelevant, immaterial and incompetent in this cause.

[fol. 1100] Judge Allen: Now, which particular figure do you say is excluded by the evidence before the Court?

Mr. R. T. Jackson: In the first place the report to Congress, if your Honor please, I think Complainants' Exhibit 115, show different volumes. Complainants' Exhibit 698 is the resolution of the Board of Directors which shows the levels that were fixed by the Board and which are now apparently subject to be changed by this witness.

Judge Martin: Mr. Bowman, I notice on Exhibit 46 of the witness that the elevation of the top gauge is shown 685, while on the resolution you say the height for the surcharge or flood control is 685. Is that merely a different terminology?

Mr. R. T. Jackson: That is the top of the flood control, anything above that would be the top of the gates, and the other elevations could not be.

Judge Gore: Will you read those figures?

Mr. R. T. Jackson: The resolution of the Board, shows a minimum pool elevation of 875.

Judge Gore: Rather low.

Mr. R. T. Jackson: It would correspond to what they have undertaken to call navigation level. Then they have fixed normal pool level of 682, which is not shown at all. The normal pool level, as I understand, would represent the power draw-down, 682 to 675. That is not on the report at all. Then they have fixed one elevation of surcharge for malarial control, which would provide a foot above that, for mosquito control. Then they have a surcharge for flood control, of the remaining 6 feet up to the top, 685.

Mr. Fitts: Of course, I might point out before going further that the Board's resolution creating the department of water control planning, in placing the operation of these dams completely under the control of the Chief of Water Control Planning Engineer, to issue instructions from day to day, week to week, as the levels should be changed, as he thinks they should be operated, it seems to me would supersede any previous action arbitrarily fixing pool levels in the dam.

Judge Allen: What is the date of the action of the Board of Directors?

Mr. Fitts: August 21, 1936, which is prior to the water control planning resolution.

Mr. R. T. Jackson: The time has actually no bearing on my objection, and my objection is not in any way limited [fol. 1100a] by Mr. Fitts' observation, because I think no such power should or could be authorized by the resolution, undertaking as he says, to delegate authority to some man other than the witness on the stand. And I want to make the further observation, if I may, if that is right, then they have delegated authority to fix the pool level at 2 feet, 3 feet, 6 feet, whatever he wants, which is preposterous.

Mr. Fitts: I think they have —

Mr. R. T. Jackson: I think in no way can the last resolution be right, even if it were to be what you say.

[fol. 1101] Q. Mr. Bowman, referring to those two exhibits which you have before you, can you explain to the Court the difference in the use of terminology, of the term surcharge, as it is used in your exhibits which you have produced here and as it is used by counsel for complainants, in referring to complainants' exhibit 698, which has reference particularly to the pool levels at the Chickamauga project?

Mr. R. T. Jackson: Mr. Fitts, have you any explanation in the minutes about that?

Mr. Fitts: I am asking the witness, who is familiar with the actual operation of the dams and as to the way in which they are designed, and the way in which they will be operated.

Mr. R. T. Jackson: I object to that. That is dealing with an official action of the Tennessee Valley Authority which cannot be shown by the testimony of an engineer.

Mr. Fitts: I am asking him to explain the difference in the terms, if there is any.

Judge Allen: He may answer.

A. On Complainants' Exhibit 698, there is the term 'Surcharge for flood control, elevation 685.' This elevation corresponds and is the same as the elevation of the top gates, 685 feet. The elevation of the top gates, when seated on the spillway crest, fixes the top of the flood control surcharge. The depth of surcharge is determined by the difference in elevation between the elevation of the top of the gates and the navigation level, the navigation level in Defendants' Exhibit 46 being 673.5 feet or a depth of 11.5 feet. On Complainants' Exhibit 698, the normal pool level elevation of 682 refers simply to the highest elevation to which the water will probably be raised during the low water season. That is to a great extent on account of the necessary operations for mosquito and malarial control. There is a surcharge for the malarial control on Complainants' Exhibit shown as elevation 683. This is the height to which the health and medical section consider it is necessary to raise the pool at the beginning of the malarial season, or the height to which it should be raised. Then, shortly after the start it will be dropped off, and that is what is known on Complainants' Exhibit as elevation 682. Below that elevation there is a depth of probably 3

or 4 feet that during the summer will be required for malarial control fluctuations. In other words, you have some considerable elevation above the minimum flat pool, which is 675, designated on Complainants' Exhibit as 'Minimum pool level,' in order that these fluctuations for malarial control can be performed without impinging upon the navigation pool level. The so-called normal pool level is based to a considerable extent on those considerations."

On Defendants' Exhibit 44, I have used flood surcharge to denominate the space which, in the usual flood season, will be available above the level at which the pool must be maintained to maintain navigation depths. I would say that is what might be termed the normal flow, or average flow of the river during the season in which floods may be expected to occur. I have called "Flood surcharge" all of the space between the top of the gates and the level at which the pool must be maintained at that time of the year in order to maintain the navigable depth. The elevation on Complainants' Exhibit 698, denominated as "Normal pool level," is applied for the 1-foot malarial control surcharge, that is the maximum level at which it is expected to stand during the low season. It is more or less a transitory elevation, but for the purpose of talking about some elevation in there you have to have a term that may designate that point, and we more or less arbitrarily called that the normal pool level. A 675 pool level is required to give a minimum 11-foot depth for the normal pool, and 682 would give 7 feet additional, or a total of 18 feet to the Watts Bar Dam.

[fol. 1103] On Complainants' Exhibit 698 the minimum pool level is stated to be 675. On Defendants' Exhibit 44, it appears at elevation 673.5. The explanation is that Complainants' Exhibit 698 might have been a little more specific. That refers to the flat pool level, assuming no flow in the river, and it is the elevation which you will have to have in the pool in order to create the necessary navigable depth at Watts Bar. That 675 is the depth required at Watts Bar, and if there was no flow in the river, that would be assumed to be low at the dam. On the other hand, if there is a flow in the river and backwater current obtains throughout the distance of the pool, which is a distance of about 59 miles, the water surface at the dam can be pulled very

conservatively a foot and a half lower, and at the same time maintain the elevation of 675 at Watts Bar.

In raising the pool level during the rainy season to an elevation of 682, that is not in general an operation beneficial to the production of power, because if you have a series of dams and at each dam you have an overlap, as we do for navigation purposes, if you operate on the chain principle, when you raise one pool, you raise the other pools, and between the first dam and the last dam you have no change in the total head, which, of course, is the figure, in addition to the flow, on which the generation of power depends.

“Mr. Fitts: We renew our offer that this exhibit be received in evidence, the table containing the figures with respect to the Chickamauga project, as defendants’ exhibit 46.

Mr. R. T. Jackson: We renew our objection on the ground previously stated:

Judge Allen: Objection overruled. It may be received.

Mr. R. T. Jackson: Exception.”

[fol. 1104] With the exception of minor differences which were brought about by changes in location of dams, and that sort of thing, in general principle the normal pool level referred to in House Document 328 corresponds, not in exact figures, but in principle, and in many cases in exact figures, to what we term the low navigation level. The space between what we call navigation level and the top of the gates as shown on my exhibit is comparable to the 10-foot flood surcharge which is mentioned by Colonel Watkins in connection with the high dam plan set out in House Document 328. At some of the dams it is exactly the same. Take at Pickwick, for instance, our navigation level is 408 and in House Document 328 the normal pool level was denominated 408. In the Pickwick Dam as it is being built, and in House Document 328, the elevation 418 was used in both cases as the top of the surcharge. In some of the other dams, on account of having to vary those levels somewhat, the results are slightly different—in some cases a little less and in some cases a little more.

The table (offered and received in evidence as Defendants’ Exhibit 47) headed “Watts Bar Project, tentative” was prepared by me.

"Q. Do those figures represent your judgment and your opinion as to the actual figures that should be adopted in the construction of that project?

Mr. R. T. Jackson: Just a moment. I object to that, because what this engineer thinks ought to be adopted, and what we think or a dozen other engineers think ought to be adopted is irrelevant and immaterial. The question is what the Tennessee Valley Authority has done. They have made their report to Congress. If they have taken any other authoritative action they can show it.

Judge Allen: The objection is sustained to that question. Qualify the witness further.

Q. Mr. Bowman, do those figures represent the tentative recommendations with reference to those projects?

Mr. Fitts: These dams are both in the preliminary in-[fol. 1105] vestigating stage, and it is difficult to get anything very definite in the way of construction figures because the exploration of the sites, as I understand it, is still under way, although I think the Watts Bar site has been definitely selected.

Q. Is that correct, Mr. Bowman?

A. It has not been officially approved, as far as I know, by a Board resolution, but it has met the approval of—

Mr. R. T. Jackson: Just a minute. I object to the witness saying anything more than it has not been officially approved by Board resolution. Whether it has met the approval of someone else, or anything else than formal recommendations are outside of the issues that we ought to have to rebut in this case.

Judge Allen: The witness may complete his answer so that the court may have the information.

Mr. R. T. Jackson: May I have an exception?

A. I might say we have done very extensive foundation exploration at that site over the past two years. It has been investigated, visited repeatedly by the higher officials in the engineering departments."

I am the Head Project Planning Engineer of the TVA. My duties are to investigate the various stretches of the river, determine the feasible dam sites, at these sites to

prosecute the exploration of the various phases which enter into the construction of the dam, carry them to completion, prepare cost estimates of various schemes and alternatives.

Examination by the Court:

This Watts Bar project comes under my direct jurisdiction. We have been studying the project now for something like two years, and consider that we have the preliminary designs refined to the point where they represent what, in our best judgment, should be built at that site. These figures are based on that information and those studies.

Cross-examination:

In my duties I investigate the location of dams and investigate designs for dams, and things of that character. [fol. 1106] After I have done that, I sometimes make recommendations to the board to my superior officers. I never go out and build a \$41,000,000 dam without any authorization of the Board, merely because I have been engaged in making designs and explorations of the river. As a matter of fact there cannot be anything done under any design, no matter how long I work on it, unless and until it is authorized by the Board of the TVA. I am not the head, or executive, or managing officer of the TVA.

Direct examination continued:

"Mr. Fitts: We offer in evidence as Defendants' Exhibit No. 47 the table relating to the Watts Bar project as representing the best judgment and estimates of the witness on the stand.

Mr. R. T. Jackson: And we object to it because the witness has no authority whatever, it is utterly incompetent, irrelevant and immaterial. The Board of Directors which does have authority for the Tennessee Valley Authority has made representations and reports to Congress upon this project, and whatever ideas any subordinate engineer may have, whether it varies with those reports of the Authority to Congress or not, is utterly incompetent, irrelevant and immaterial.

Mr. Fitts: We also offer this as showing the present status of the plans as produced by the witness, who is in charge of the plans.

Mr. R. T. Jackson: We object on the same ground because there is no approval of the plans by the Board, and no adoption.

Judge Allen: The objection is overruled. And the Court considers that the objection goes to the weight rather than to the competency, and that this testimony from a man actually engaged in this work, on these particular projects is surely at least as competent as the hypothetical testimony which has been permitted to be introduced on behalf of the complainants with respect to these projects.

Mr. R. T. Jackson: May we have our exception, and in order that I may not be charged with having been obscure in my statement to the Court, as I fear I have, we are not here asking an injunction against the hypothetical plans.

Judge Allen: The Court understands that.

[fol. 1107] Mr. R. T. Jackson: I just wanted to go a step further, if I may. That testimony was offered as bearing upon the character of the plan actually adopted by the Tennessee Valley Authority and actually recommended to Congress.

Judge Allen: The objection is overruled. The Court is not ruling upon the weight of this testimony. It considers it competent, and that your objection goes to the weight. You may have your exceptions."

The table (offered and received in evidence as Defendants' Exhibit 48) entitled "Coulter Shoals Project, Tentative," was prepared by me. The Coulter Shoals project and the Watts Bar project, concerning which I have just testified, are in the same general status. These figures are based upon my investigation and the studies that have been made under my general supervision and control.

"Mr. Fitts: I am offering in evidence the table referred to as Defendants' Exhibit No. 48.

Mr. R. T. Jackson: We make an objection to this exhibit 48 upon all of the grounds which I have stated with reference to exhibit 47, and I will ask the witness to say with reference to my qualifying questions that they apply as fully to this project as the one covered by exhibit No. 47. Is that right? I asked you several qualifying questions with reference to exhibit 47 which you offered on Watts Bar, as to whether or not this project had ever been adopted by the Board of the Tennessee Valley Authority and as to

your position with reference to investigations and recommendations. Now, without repeating these questions can you say that the situation is just the same with reference to Coulter Shoals, shown on exhibit 48?

The Witness: Yes, to the best of my knowledge it is just the same.

Mr. R. T. Jackson: Now, I want to avoid asking the same questions again.

Judge Allen: Is it understood that the same qualifying questions may be considered as asked of the witness by Mr. Fitts?

Mr. Fitts: Are you willing to have the record show it is understood that the same questions asked, would be asked and answered?

[fol. 1108] Mr. R. T. Jackson: Those that you asked after I asked the qualifying questions, if that is what you mean, I am willing to agree that each of those questions, if put to the witness, he would make the same answers.

Mr. Fly: May I have 30 seconds. I do not think it is contended here that the Board of Directors adopted these plans or details for any of the projects. The non-justiciable issue which the complainants have presented is not one that we brought up, that is one that they have to contend with. And if they want to attack the dams in their present tentative state, they ought to proceed, and if not they should withdraw their charge.

Judge Allen: The objection has been made and overruled."

The photograph (offered and received in evidence as Defendants' Exhibit 49) is of Norris Dam, which is already constructed and in operation. This is a photograph of a perspective of Norris Dam, the section being that from the east bank of the river over to the west bank, with two sections of the masonry removed in order to show the sluiceways and penstocks leading to the power unit.

Examination by the Court:

As I stated, this is a photograph of a perspective drawing of the Norris Dam with sections of the dam removed in order to illustrate more clearly the mechanical operations. The drawing is made looking from the east over across the top of the dam and in the general direction of Coal

Creek. To the right is the upstream side of the dam, or the pool, and to the left the down-stream side of the dam is, of course, the natural stage of the Clinch River. Taking the portion of the dam shown to the left, that is the first section in the background, this shows the spillway gates on the top of the dam, the complete gate shown in the background being taken with the greatest elevation of 1020, [fol. 1109] which we refer to as the fixed crest of the dam. The gap in the foreground which is shown in the cross section in red, with the tow of the pool underneath it, showing the water in the operating chamber under the gate. The gate is raised to its full height, which is elevation 1034.

The lower part of this section shows in a wide blue line, which represents water passing through the sluiceways. The sluiceways are eight in number, 10 feet high by approximately 6 feet wide, and having a total discharge capacity of 36,000 cubic feet per second. The flow is controlled by two gates near the upper end of the conduit, one the operating gate, the other an emergency or sliding gate, which simply slides down across the conduit and shuts off the water.

These sluice gates permit the draw-down of water from the lower part of the pool. After the water in the pool is drawn down to elevation 1020, of course the spillway at that point is fixed and no water can be discharged over the spillway at that time. So the sluiceways are provided to draw the pool down to an elevation lower than can be drawn by the spillway gates. In the section in the foreground is shown the power house with the generating unit in section. Approaching the power house from the upstream side of the dam is a wide blue streak which is the water in the conduit approaching the unit. That conduit is continuous as indicated by the dotted line and leads into a spiral conduit which surrounds the turbine, which is the mechanical part of the equipment shown, and from that spiral down through the turbine it goes out to the water below the power house.

[fol. 1109a] Direct examination continued:

I want to correct a misstatement in an answer I made earlier. The correction is with reference to whether the adding of water to the normal pool level would have any effect on the power output, and my mind was running in a groove on the additional head which might be created,

which, I said there would be no additional head. However, there would be the possibility of additional power through the draw-down from that normal pool to the low pool [fol. 1110] level. Of course, that would increase the flow at each plant below, and consequently the possible output.

Referring again to the water going through the conduit into the turbines, I might add that down at the lower part is shown the turbine, with the turbine blades, and at the upper part of that equipment a flat disc-shaped object is the generator. The generator is connected with the turbine on the same vertical shaft so that the turbine revolves at a certain speed, which is fixed, and the generator revolves at the same speed as the turbine.

There is another element which might be explained, that is the operation of these spillway gates. This gate is what is known as the drum type gate, which is 100 feet long and 14 feet high, somewhat triangular in shape, although the sides are not planes. It is hinged to the masonry crest at the upstream side, and the gate itself is water tight; in other words, it is simply a large float. When it is down, it falls into this chamber underneath the gate. When you raise it, water is admitted into this chamber to any depth, which is controlled by valves, and the gate simply floats up on top of that water, and is held at the desired elevation. Of course, if you want to let it down, the outlets are opened and the water flows out on the downstream side and the gate floats down on the surface as the water goes down. The difference from the top of the gate to the top of the dam is 14 feet in elevation. When the gate is folded clear down and when fully raised, it is 14 feet. By that operation it is possible to get additional storage behind the gates above the dam.

The chart (offered and received in evidence as Defendants' Exhibit 50) was prepared under my supervision and direction. The information shown there is accurate and correct to the best of my knowledge. The figures and the design are actually as shown for Norris Dam. The figures [fol. 1111] and design for Hiwassee are taken from the designs, on the basis of which Hiwassee Dam is being constructed. It is now actually under construction, on the basis of the designs which are represented on this exhibit.

"Mr. Fitts: We offer in evidence Defendants' Exhibit No. 50, about which the witness has just testified and identified.

Mr. R. T. Jackson: We except, so far as it relates to Hiwassee storage because there is no showing there has been any particular action of the Tennessee Valley Authority Board of Directors, which has formally approved any figures or has formally approved these figures, or has changed anything in the plan which they submitted to the Congress.

Judge Allen: Objection overruled.

Mr. R. T. Jackson: May we have our exception, please?"

The two diagrams on the right hand side of the chart are what we call storage volume curves, which simply show by the figures which are given there, or at any other elevation which might be scaled,—that scale is an exact scale, or proportional scale,—the volume at any particular elevation can be obtained.

I might describe briefly for the Court the means of preparation of these. The topographic map of the reservoir is used. This topographic map gives the contours from the dam site up on one side of the reservoir, and back, at different elevations. The area inside of these contours is measured, and the volume determined by multiplying the height interval between the contours selected, which of course gives the volume. Then, adding the different volumes up from the bottom of the reservoir at the dam successively to whatever height is desired gives the cumulative volume to a particular elevation from the bottom of the reservoir at dam up to any surface elevation selected.

3,140,000 is the cumulative volume up from elevation 820, which is the stream bed at the dam site, up to elevation [fol. 1112] 1047. The figure 900 is an intermediate elevation at 900 for 80 feet above the stream bed. At that point the chart shows the cumulative volume is 108,000 acre feet. If I remember Mr. Kurtz' testimony correctly, the space between 820 and 955, which is shown as cumulative 554,000 acre feet, is the space that was denominated by Mr. Kurtz in his testimony as dead storage. The 1005 level is the level 15 feet below the fixed crest of the dam. It is simply an elevation, and at that point the storage volume given was 1,578,000 acre feet. That is the total volume from the stream bed up to that elevation. I believe that the space in here which Mr. Kurtz denominated "power storage" was from 955 to 1020, if I am not mistaken. I think Mr. Kurtz denominated the space above 1020 up to 1034 as "depend-

able storage". I do not recall that he did anything from 1034 to 1041.

The Hiwassee curve was prepared in the same manner and presents the information in the same manner as the chart for Norris. That is, the stream bed at the dam is approximately elevation 1280. I think perhaps that is low water surface. At elevation 1415 apparently the storage volume is 73,300. At elevation 1465 the volume is 172,600 acre feet, and at elevation 1526 the volume is 434,800 acre feet. I think the elevation 1526 is 6 inches below the top of the gates.

The table (offered and received in evidence as Defendants' Exhibit 51) is entitled "Norris Project". The figures are actual and not estimates.

Cross-examination:

The table does not show any minimum draw-down level or normal pool elevation, or anything of that kind.

[fol. 1113] Direct examination continued:

The table (offered and received in evidence as Defendants' Exhibit 52) entitled "Hiwassee project", was prepared by me from figures prepared under my supervision. They are figures taken from the design drawings under which the dam is being constructed, and they are not actual figures.

"Mr. Fitts: We offer in evidence the exhibit just referred to as Defendants' Exhibit No. 52.

Mr. R. T. Jackson: May I ask one question? Has the design, insofar as it is reflected by the data shown on exhibit 52, been adopted by the Board of Directors of the Tennessee Valley Authority?

The Witness: Well, I presume it must have been because they are spending appropriations for that, and certainly it must have had the approval of the Board.

Mr. R. T. Jackson: Will you produce the resolution later then?

Mr. Fitts: I don't think there is any.

Q. Mr. Bowman, using your definition of controlled flood storage as you have given it in your testimony, I will ask you to state what the total amount of controlled flood storage is in the combined dams, taking the following dams,

Gilbertsville, Pickwick, Wheeler, Guntersville, Chickamauga, Watts Bar, Coulter Shoals, Norris and Hiwassee?

A. I will have to refer to my notes.

Mr. R. T. Jackson: We object to the question because—first I want to ask is this question based upon any designs that have been adopted by the Board for Gilbertsville, Watts Bar, Coulter Shoals, Hiwassee? I object to the question insofar as it involves an estimate or computation based upon some designs that this witness has drawn up, but which have not been adopted by the Board of the Tennessee Valley Authority.

Mr. Fitts: I would like to state the complainants have elected in this case, in the bill of complaint, to challenge the constitutional authority to construct these dams. Since they have done so, the best I can do is present to the Court the present plan for the construction of these dams. If it is too vague to be presented in evidence, it is too vague to be litigated. It seems to me it follows as a matter of course.

[fol. 1114] Mr. R. T. Jackson: Of course, Mr. Fitts has completely misconceived or misstated the position. We have a very definite program submitted to Congress by this Corporation and by the Board of Directors. And the question that is here involved is whether that may be changed and another program substituted by any employee of the TVA who chooses to take the stand and say that he conceivably might do something else if he were doing it.

Judge Allen: The objection is overruled. He may answer.

Mr. R. T. Jackson: Exception noted, please.

Judge Allen: Exhibit No. 52 is received."

Using my definition of controlled flood storage, the total amount of controlled flood storage in the combined dams, Gilbertsville, Pickwick, Wheeler, Guntersville, Chickamauga, Watts Bar, Coulter Shoals, Norris, and Hiwassee, based on the elevations which have been shown, is a total controlled flood storage of 8,925,000 acre feet. That includes a slight amount for Wilson Dam, 43,000 acre feet.

Cross-examination:

Defendants' Exhibit 37 is an artist's conception of a dam and lock superimposed upon the site of Chickamauga,

showing a towboat and barge in the lock. It is obviously not drawn to scale. I do not think a barge and towboat of that size would carry 100 tons. They would have to be pretty deep.

Referring to Defendants' Exhibit 38, the drawing of Gilbertsville Dam, I think the sketches for it were prepared sometime last summer. I do not know exactly when the draftsmen completed this. It was prepared under my direction. I prepared the rough pencil sketches for the layout, then the artists completed them when they got around to it. I think it was sometime last August when I gave him the information to go ahead with that. The glow just back of the dam has no significance. It is an artistic touch. I [fol. 1115] gave the data to the artists sometime in the summer of 1937. Of course, the preliminary designs have been hashed over, rearranged, for the last year and a half or two years. They have been in the process of evolution, but as I remember, I gave the artists the data sometime last summer. This evolution had been completed sometime last summer. This has been prepared in the regular course of business. But for the last year, our consulting board has made trips to Knoxville and advised us on what pool levels we could consider, all that sort of thing. At the time this information was given out, it was the best information our design men and our consultants had worked out, up to that date, to represent the present status of their recommendation. It reached the stage shown on this exhibit in 1937. It was then that we finally came around to this data, and I should say that in July or August, some time, we arrived at these conclusions. I was doing practically nothing in preparation for this lawsuit at that time. I had given out a little information. I talked with the lawyers a little bit, and I devoted 8 or 10 hours to the whole case prior to that time.

Information of the character shown on Defendants' Exhibit 38 comes to my attention. I have a squad of men assigned to preliminary design of the Gilbertsville project, and they are working under my supervision.

I stated in Defendants' Exhibit 39, the typed table, that under this design there would be 6,150,000 acre feet of storage. In the course of my duties, I knew that the TVA had a hearing and submitted data to the sub-committee of the Appropriations Committee of the House of Represen-

tatives on Monday of this week in support of an application for appropriation of money for the TVA. I did not know that at that hearing the data submitted to the sub-committee of the Appropriations Committee of the House stated that the total volume of storage at Gilbertsville would only [fol. 1116] be 4,850,000 acre feet. I assume it was the official presentation of data by the TVA to Congress in request for an appropriation. That sounds like the figure used a year or two previously.

"Q. Yes, as matter of fact it is exactly the same figure the Tennessee Valley Authority in appearing before the Committees of Congress told the Committee of Congress that was the capacity of storage of Gilbertsville Dam, isn't it?

A. If that is correct, that is what they told them.

Q. Well, I have not asked about whether it was correct.

Mr. Fitts: He has not seen the figures.

The Witness: I have not seen the figures.

Mr. R. T. Jackson: Well, I will show you the figures. I thought you were familiar with all those figures.

A. Well, I have had nothing to do with those, yet."

4,850,000 acre feet is the figure previously presented. I am familiar with that. I furnished the figure. That was the figure at the time of the study of the preliminary plans, which has gone forward, and since then that has gone forward.

The ninth item on Defendants' Exhibit 39 shows that the controlled flood surcharge in acre feet at Gilbertsville project is 4,600,000. I do not know it to be a fact that the TVA in submitting data to the Committee of the Congress on Monday of this week told Congress that the controlled storage of all kinds at Gilbertsville really would be only 3,700,000 acre feet.

For a flat pool level, that is with no flow in the river, the elevation of what I call the navigation pool at Gilbertsville would be elevation 354. That is the depth required in the Pickwick vicinity to avoid excessive dredging into the lock entrance. The total volume of Gilbertsville reservoir below elevation 354 is, as closely as I can read it off of this curve, 2,000,000 acre feet. I do not believe we have yet fixed any normal elevation. It would be as far above elevation

354 as would be required for the malaria control manipulations. That is in the summer time when you have this malaria control surcharge, we are apt to have practically a flat pool, because the flow in the river gets very low. In order to not go below that we would have to raise the normal pool as far above that as would be required for malaria control. I think perhaps finally that would be fixed somewhere between 3 and 5 feet.

“Q. Well, do you not know now, Mr. Bowman that the Tennessee Valley Authority in submitting its data to the Congressional Committee Monday, asking for an appropriation, fixed the normal reservoir elevation at Gilbertsville at 359?

A. Well, you take 54 and add 5 feet, which I just stated, I said 3 to 5 feet, makes elevation 359. And in all probability that is very close, although that has not been officially fixed.

Q. Well no, I understand there is nothing officially fixed about these figures that you have given, but did you recommend that 359?

A. I think any recommendations that we have made so far have been somewhere between 357 and 359, and somebody took the 359 figure apparently in this report.

Q. Now, will you tell me the volume of the reservoir—

Judge Allen: Were you present in Washington at this hearing?

The Witness: No, your Honor, I was down here in the Court room.

Judge Allen: Have you read any figures?

The Witness: I have not read the figures, and I didn't know in advance what figures they were going to present.

Judge Allen: Do you have any knowledge of the figures there that were presented?

The Witness: The only knowledge that I have is apparently from what Mr. Jackson says, that a table from last year's hearings was presented by the Comptroller, or somebody without realizing that some of these projects were in the process of evolution during the last year.

[fol. 1117-a] Q. Mr. Bowman, to set your mind at rest on that, the table is dated September 29, 1937.

Mr. Fly: I move to strike that remark of counsel. He is not on the witness stand here, your Honor.

Mr. R. T. Jackson: Well, you have made a great many without being sworn. Do you want to produce a copy of the data, Mr. Fly?

Mr. Fly: I haven't got it, but I will be happy to produce it after this goings-on.

Mr. R. T. Jackson: I am glad to hear it.

Judge Allen: The objection is sustained. The witness [fol. 1118] has said that he was not there and he has no knowledge of the figures except what Mr. Jackson has given him and Mr. Jackson is not a witness.

Mr. R. T. Jackson: I want the same ruling against Mr. Fly if I can get it. Exception please."

The figures about which you have been asking me fall within the field of what I said were my duties. I furnished the figures which have been quoted a year ago for the Appropriations Hearing, and apparently the same figures have been carried over. Because I was down here, apparently I was not asked to check those tables this year again, when they were submitted. I have not seen such a table at any time since September 29, 1937. I have seen none of the material which was prepared for this hearing.

I can not give the scale of the outline of the Gilbertsville pool on the left-hand side of Defendants' Exhibit 38. The scale is not given on and does not show the original chart. We might find out from the artists what scale they used in plotting that. I don't know. There is a map showing Gilbertsville reservoir at normal stage. I have an extremely small scale map here entitled "Permanent capacity of the Gilbertsville reservoir and surrounding territory", (marked for identification Complainants' Exhibit 903) showing the Gilbertsville reservoir at normal stage. The maximum width of the Gilbertsville pool measures about $2\frac{1}{2}$ miles. The elevation on which this tabulation is drawn, this contour line, shows elevation 370. In Defendants' Exhibit 39 I show elevation 375. That would make some difference. I can explain that elevation. This map was prepared last April, and at that time we had not completed our topography up as high as 375, so we sketched on there the best that we did have as of that date. I have not here a contour map showing an elevation 375 for the Gilbertsville pool. I don't know whether I have one. I can

find out. If we did not have a contour map, the volume [fol. 1119] of the reservoir at the top of the gates in acre-feet may have been taken by cross-sections of the pool above the 370 contour. I can find out whether it was a map or whether it was cross sections. I know that there was some information of that sort taken, but I don't recall whether there was either one or exactly the nature of it. This was a year ago that that field work was done. This 6,150,000 acre-feet figure was made under my direction.

When this Gilbertsville pool is at what I call navigation level, the depth in the upper end of the pool is at 50, except for dredging over some of the shoals in the upper end. At the time the 350 would be used at the dam, the elevation at the Pickwick Lock would be 354. It will require some dredging in that vicinity to get the full 12-foot gross depth into the Pickwick Lock. There would not be 12 feet at that elevation in the upper end of the pool without a minor amount of dredging. There are some bars and Big Bend Shoals downstream from the lock. It would obviously be cheaper to take out the bars than to do anything else.

I have a curve here that shows the surface area of the Pickwick Landing pool at the maximum draw-down and at normal pool levels. I don't have a map which will show the width of the pool at various places. Defendants' Exhibit 40 on Pickwick Landing Dam and Wheeler Dam is not to scale and is not subject to being read. The artist has exaggerated the width. The brush was too wide, I guess.

I do not believe I can furnish the figure right now as to the estimated cost of Gilbertsville at elevation 375 with the extra five feet of elevation, but I can give you a rough approximation. As Gilbertsville Dam was previously reported to Congress by the TVA, it carried an estimate of [fol. 1120] \$112,000,000 for completion with a complete power installation. The addition of 5 feet to the height of Gilbertsville Dam would increase that estimate of cost very little, if any. You would have to increase the elevation of the top of the gates and a slight amount on the embankments. The clearing in the reservoir is taken care of in the previous estimate. It would flood more 5 feet higher, but as I remember the clearing has been estimated about up to level 380 in the previous estimate, which for some reason or other got by. We found out, if my recollec-

tion is correct, that bringing that clearing down to elevation 375 about offset the additional cost of the height of the dam. So, the estimate stands about where it did, although there would be an actual difference between the 370 and the 375. This results simply because there was a little overpadding in the previous estimate.

The TVA did not previously report to Congress that they were clearing something beyond the edge of the pool at high-water elevation. Normally what we clear is up to the top of the malaria surcharge, in order to eliminate the brush and leaves of trees, and that sort of thing from the shore line, which will be occupied by the pool during the mosquito-breeding season. My testimony is not that raising a dam 5 feet does not require widening the base. What I stated was that the over-estimate in clearing in the previous estimate approximately made up for the additional cost of the dam. I do not have the figures as to the amount of over-estimate in mind. I would not say that I do not know what they are, but believe they are about equal. There would actually be a difference in the cost between 370 and 375, but, as I remember, the revised estimate for 375 does not exceed the original estimate of 370. The original estimate for 370 was too high. I do not know now what would be the cost of raising the original dam or the cost of clearing. That is just my estimate.

[fol. 1121] The length of the dredged channel which will be required between the head of 9-foot navigation in the Hales Bar pool to Chickamauga will be roughly 7 miles. It will be from Chattanooga Island upstream, from the Walnut Street Bridge in Chattanooga, up to Chickamauga Dam. That is the total distance, but the dredging consists of dredging in isolated bars, and between those bars are places of considerably more than the required navigable depth.

I do not believe that I could tell you offhand for what percentage of time what I call the navigation pool level will be maintained at each of these TVA main-river dams. I can tell you approximately; it will be maintained at that level with minor fluctuations from the beginning of the flood season, say the middle of December, up until—it varies in different places, perhaps slightly—along toward the first of May. That is fairly accurate for each of the pools.

It is difficult to answer what per cent of the year the normal pool level would be maintained at each of these main-

river reservoirs, for the reason that the normal pool levels are purely an arbitrary definition and are sort of average points. Perhaps the top point in there is very transitory, because of fluctuations. You would have to make a tremendous number of assumptions, saying it might not be released in actual operations, to get that figure. For the purpose of malaria control you would fill up beyond the normal pool level a foot about the first of May, and you would hold it there until about the first of June to kill out the vegetation along the margin. Then you would release that, drop the pool a foot, and from there on it would have rather steady fluctuations in order to keep the drift stranded along the pool, and at the same time draw away from that level.

[fol. 1122] Directing my attention to the normal elevations of the main river dams shown on the TVA Report to Congress under date of March 31, 1936 (Complainants' Exhibit 328), and illustrated by the normal elevation of 595 shown for Gunter'sville in that report, it is extremely difficult to answer what per cent of the year the normal level would be maintained at each of the main river dams, for the reason you are surcharging floods when you get a flood above that elevation, and then letting the flood stay until it can be released. And during the summer season you build up above that a foot and drop as soon as the vegetation is killed. Then the fluctuation below that, sometimes up to it. So that it is a rather difficult job to combine all of those things and say what percentage of the year it would be right at that elevation.

"Q. You have already told me the time of the year during which these pools will be at what you call navigation level. Now, that gets rid of a part of the year. Now, you have said that you will try to make your best estimate of the part of the year during which the pools are at normal pool level—that takes another part of the year. Now, I am asking you if whatever part of the year remains, the elevation of the pools will not be between normal pool level and maximum pool level?

A. If I get your question correctly, Mr. Jackson, during the time when you might have sufficient floods to raise the pool above normal pool level, there would be a time that if the floods were sufficient the surface of the pool would be surcharged somewhere between low level and maximum level. That might either be below or above the so-called

normal level, depending on the size of the flood which you catch. So it seems to me that your conclusion is not correct.

Mr. R. T. Jackson: I am afraid you do not understand my question.

Judge Allen: Has he answered the question? Is the answer no to the question?

The Witness: As I understand the question, my answer is no.

Mr. R. T. Jackson: I do not want to impose on the Court, but I am sure the witness does not understand the question. I assume it is my fault.

[fol. 1122a] Judge Allen: Read the question.

(The question was thereupon read by the reporter.)

Judge Allen: Do you understand the question?

A. I think I do, your Honor, but it is a little bit involved. I have to look at this, if I might. It is about like a Chinese puzzle. My answer still is, Mr. Jackson, that it seems to me under your question there would still be a percentage of time left in which the pool would be between low and normal and not above normal. Of course we will have to draw some diagrams of this thing between us, I guess."

At the mouth of the Tennessee River and going up, excluding Gilbertsville, the level in the navigation pools during the low flow would be: At Pickwick, 408; Wheeler, 550; Gunter'sville, 593; Chickamauga, 675; Watts Bar (estimated), 736; Coulter Shoals, 805. The normal pool elevation at Pickwick is 413; Wheeler, 555; Gunter'sville, 594; Chickamauga, 683; Watts Bar (tentatively), 740, and Coulter Shoals (tentatively), 810. These latter are not elevations that are fixed by any physical thing that you can tie [fol. 1123] to, but more or less average elevations which represent about the highest elevation in the low water season, except the malaria surcharge of 1 foot above normal. I will supply the total volume of each of these reservoirs up to the normal headwater elevations after recess.

The condition with reference to the depth at the upper end of these pools on the main stream would be substantially the same condition as I have described at the upper end of the Gilbertsville pool. All of these elevations which I have given at the dam of either slack pool level or low pool level

will be the same elevation at the next lock upstream—that is, a minimum depth of 11 feet over the lock sill.

On Defendants' Exhibit 40, the figure 549 was substituted for the figure 550. In checking over we found that the artist had another figure of 550. Referring to Defendants' Exhibit 50, the figure that was eliminated at the upper right-hand corner still remains in two places on the original chart. The artist put the scale of these lines on the original chart. That was not my instructions, although I had given him the scale to draw it to. Then of course, when it was reduced that scale no longer applied to here. So just to save time we wiped both out. I left instructions to have those stricken out on the big map. I thought they were until I noticed when it was put on the stand.

With reference to Defendants' Exhibit 50, which contains a diagram of Norris and Hiwassee Dams, we show a line 955 with storage of 554,000 acre feet. That line has sometimes been indicated as the maximum draw-down line in previous reports to Congress. We just gave the information on the report. The elevation 1020 is what has been designated as the normal pool level in previous reports to [fol. 1124] Congress. That is the fixed crest of the spillway. I don't recall that that was also the elevation to which the TVA advised Congress they hoped to have the dam filled at the beginning of the low-water season, but I do believe it has been referred to as "normal pool level". We show space between 1020 and 1034, which actually has storage capacity of slightly over 500,000 acre feet. That has been designated in those reports to Congress as the storage capacity that was reserved exclusively for flood control, the intention being that that should not be filled up or encroached upon for power purposes, or anything except flood control. The other lines running finally up to elevation 1047 are merely the space above the top of the gates.

I suppose we could have shown an elevation as much higher than 1047 as we wanted to in order to get a still larger capacity in acre feet. We could have completed the capacity up to the top of the roadway maybe. That is not this much discussed valley storage on stilts. I think that statement is based on an assumption that you could go on and on, up and upwards. As to whether the storage capacity which I show between elevations 1034 and 1047 is really this much discussed valley storage on stilts, it gives the same effect as a detention basin would for that type of storage—that is,

there is no control there, no gate to hold it, it can pond up and fill, and then gradually bleed out. I don't claim to be much of an expert on valley storage but it would be approximately something of that sort.

To the extent that the figures and data I have given on these various main stream and tributary dams of TVA are not in accordance with the data submitted by TVA to the Congressional Committee last Monday, I have no information about it. I am not familiar with, and know nothing about, what TVA put in last Monday for Gilbertsville Dam, [fol. 1125] and that situation is true with every one of these dams as far as that report is concerned. I know nothing about what was submitted except what you have told me, and I judge from that that it must have been a table prepared last year that was inadvertently included with the Comptroller's request.

"Mr. R. T. Jackson: I move to strike out his judgment about the matter, with which he is not familiar.

Judge Allen: It may stand.

Mr. R. T. Jackson: May we have our exception, please? I understand Mr. Fly is going to furnish us with a copy of that data. Is that right, Mr. Fly?

Mr. Fly: When the—I don't have a copy of it. I understand that—

Mr. R. T. Jackson: Well, I understood you to say you would furnish us with a copy of this table that was submitted to Congress last Monday.

Mr. Fly: I will say this, when the Committee releases the information, whatever it is, I will be glad to see that it is submitted. If the Committee has retained it confidential for the time being, I of course cannot violate that confidence. But as soon as it is released I will be glad to see that it is produced here.

Mr. R. T. Jackson: You have copies. Did the Committee impose any restriction on TVA?"

As to whether the table on page 59 of Complainants' Exhibit 328, being the Report of the TVA to Congress under date of March 31, 1936, shows that the minimum flow at Wilson Dam was to be regulated so as to increase it from 4300 second feet to 18,900 second feet during the driest year without any use of Fontana, that table shows the possibilities of regulation. It does not mean to show that that is precisely the regulated flow that will be obtained. That is

the potentiality. The graph on page 201 of my article in Civil Engineering for April, 1935, indicates that in order to [fol. 1126] have produced that regulated flow at Wilson Dam under conditions of 1925 it would have been necessary to have storage of something over 3,200,000 acre feet to draw upon. That was a preliminary calculation. I am not sure of its final correctness today, but that is what the graph shows. I do not intend to disavow the graph published in that article, but I mean in the light of more detailed studies which have been made, I can not vouch for its exact accuracy. I think it is approximately correct. Assuming that my graph is correct and that it would require at least 3,200,000 acre feet of storage at the beginning of the low water season in order to produce or maintain such a regulated flow during a year such as 1925, I can not tell the Court in what reservoirs I would have had that water stored at the opening of the low water season. You understand this graph is not made up by reference to any reservoirs but by taking the hydrograph at Wilson or Florence and figuring deficiency below a certain flow. This has no reference to where you are going to store that. We would not have encroached on the flood surcharge in the main river reservoirs above Wilson for the purpose of storing the water. As far as I can see, probably not. Of course, this does not mean—it might mean that to get the amount which is shown in this potentiality, I can not say without investigating the situation and refreshing my memory, it might mean that you would have to encroach on that somewhat to get the regulated flow. You would not have to get your storage for regulation in the head-water tributaries at Norris and Hiwassee. You can get that on the main stream pools also without encroaching on the surcharge. There is considerable flow after the end of the flood season, which you could store on the main river pools. I could not tell what would have been the elevation of the pools at March 1 and February 1, 1925, in order to provide 3,200,000 acre feet of storage. [fol. 1127] I do not believe I have ever run through that calculation. These are potentialities, and there is no indication there that that will be done. But if it was done, that was what would be required. Now, I don't know it might be that your assumption is correct. I don't believe I have ever run through that particular calculation. It may be possibly correct to say that it would be impossible to enter the low water season with 3,200,000 acre feet of storage to pro-

duce such a regulated flow under conditions existing in 1925 without not only filling the entire reservoirs at Norris and Hiwassee up to what we call the normal pool level for power purposes, but also going even beyond that and encroaching upon the area which should be reserved for flood control without encroachment for any purposes. I do not have charge of the investigation of that phase of the work, and I would have to look the thing up to find out.

You never know whether you are going to have a low water year like 1925 in February or March. You would know some low years perhaps. 1925 had a fairly ample flow in the early part of the year. If you are going to provide a definitely regulated flow during every year on some firm assumption that we are going to get that in spite of everything, it is true that you must provide storage far enough in advance of the worst water conditions to insure that possibility. I do not know of my own knowledge that we would have to have our storage reservoirs at Norris, for instance, up to 1020 or higher earlier in the season. I imagine that you would have to have it almost to 1020. I do not know at what date in the season. I don't have charge of those investigations of storage and that sort of thing. Unfortunately we can not tell what rainfall there is going to be a year ahead and all we can do is base our operating curves upon the worst experience of the past and then take [fol. 1128] that as a general rule and departing from that as hydrological conditions at a particular time justify. I think that is the way reservoir storage is operated. We can not depart from it on the basis of hydrological conditions that are in the future and not yet known, but you do know such elements as exhaustion of ground water levels and that sort of thing.

I testified in the Ashwander case and was asked the following questions and made the following answers:

“Q. Now, you are talking now about the effect of Norris below Pickwick Dam?

A. This is all the effect of Norris.

Q. Yes.

A. The present navigable depth, Big Bend Shoals, Indian Creek Shoals, represents about a minimum, particularly, because at those points the improved channel is on rock bottom. So, we have a minimum depth there of about 4½ feet at the present time under low water conditions.

This will be increased to a six foot minimum depth at these points, and, in general, we will have around seven feet or somewhat more during a large portion of the year below Pickwick Landing and to Paducah at the mouth of the Tennessee.

At the present time, almost all the time, we can obtain from natural stream flow at Wilson, 55,000 kilowatts; for continuous, it might be stated, about 50,000 kilowatts. With the release of the water in the Norris storage for low water regulation, all this power at Wilson will be increased from about 50,000 kilowatts continuous to about 90,000 kilowatts continuous. With Norris, and with the proposed inter-tie, or some inter-tie between Norris and Wilson, so that these can function essentially as a system, the continuous power at the two plants would then be 153,000 kilowatts'."

I think that that probably could be done under certain assumptions. I made a study about those storage conditions in the early days and for a time had charge of that. I no longer have charge of those studies which have been considerably revised, and in fact almost entirely done over since that was transferred to another department.

[fol. 1129] The following quotation from my article in Civil Engineering for April, 1935, page 200 correctly states my opinion:

"The major floods may occur from January to April, but the greater number come late in March or early in April. Normally, the depletion period begins in the middle of July and continues, with little replenishment, until early in December. The lowest water is in October or November.

In general the problem of regulation for flood control, navigation, and power involves conflicts of interest that cannot be completely reconciled."

I would like to say in explanation of that that it is my opinion that there is considerable misconception of this question of conflict. It is rather obvious that where you are using a part of the same space in a storage reservoir for two purposes you cannot get a hundred per cent benefit for both. That is the element of conflict. From an economic standpoint or from a feasible standpoint, as good engineering, I don't think that anyone would say that it was necessary to get results of large magnitude that you realize a hundred per cent, and try to avoid that conflict to the extent

that you get a hundred per cent of the benefits. As a matter of fact, with a small sacrifice one way or the other, a very large and substantial amount of those benefits can be secured in multiple purpose use, and it would not seem to be good engineering practice not to take advantage of that.

The following is a correct statement from the next page of my article of what can be done at Norris Dam under certain assumptions (page 201):

"The normal pool level and the maximum level for power storage will be at elevation 1020, giving a gross head of 194 ft. With a maximum draw-down of 58 feet, 1,500,000 acre feet will be available to regulate power output and navigation. This will mean an average contribution of 5,000 cubic feet per second to the low-water flow and an increase in the flow at Florence of from 10,000 to 16,000 cubic feet per second for 97 per cent of the time. With regulation by the Norris Dam, the extreme low flow will be about 12,900 cubic feet per second."

[fol. 1130] That is a correct statement of what can be done up there under certain assumptions but not a statement of what will or would be done. My statement in the article that "The normal pool level and the maximum pool level for power storage will be at elevation 1020" is all right. That represents the maximum elevation for power storage. That is correct. Except that may have been a little inadvertence there. I called it power storage. I thing it is more probably suitable to call it flood level, for low water regulation. That is not an increase in my legal education but is largely an increase in my engineering education. It is for low water regulation.

The following is a correct statement of the facts from the next page of my article:

"As the storage is progressively increased by additional construction for supplementing low stages of the river, more and more of the flow from unregulated areas is converted to firm power for the generation of primary power. Consequently less and less water can be stored without reducing the flow already utilizable at plants on the main river. The regulated flow equivalent of power produced at storage developments during the low-water season will be additional to this. For instance, the minimum power generated at the Norris Dam during the dry season would be equivalent to a flow of 7,000 cubic feet per second at the Wheeler and

Wilson Dams and to this extent will fill in the valleys of the power-hydrograph of the lower river. In this respect the Tennessee, with its many possible storage sites on the headwaters, and its long main river providing additional sites for low-head development, but with less storage, differs from many of the major rivers of the country."

That is simply pointing to the fact which a hydroelectric engineer knows, that you cannot approach too closely to the point of what some people maintain should be a uniform regulation of the stream throughout the year. That is not feasible from the engineering standpoint, and this is simply pointing out the manner in which that point is approached. Of course, that means for the development of storage water, [fol. 1131] if it is carried too far, you would more and more have to make allocations for power use or floods storage, but up to a certain point, until you get to the point which I bring out here, it is perfectly feasible to use the project for multiple purposes. If you go beyond that point, where obviously all the reserves which you can, or which you already have, you can hold all of the water, which is available in the low water year during the storage season. After that point, if you want a flood control reservoir you have to build a flood control reservoir. Or if you want a power reservoir you have to build a power reservoir. You will get some benefits from both of them. But, after you get to that point it is obvious that if you do not have water enough in the dry season to fill those reservoirs, that they are not power reservoirs and can not be used but for flood control, if you want that.

"Q. That is, if you have an empty reservoir you have a flood control reservoir?

A. I mean the entire space in the reservoir would be devoted to flood control under those conditions. Naturally if you do not have water you will not fill it up."

The following quotation from page 201 of my article correctly states the facts even in the reservoir which is devoted almost entirely to power purposes.

"At present there are only two seasonal storage reservoirs of any great magnitude in the Tennessee Valley: Santeetlah reservoir of the Aluminum Company of America, on the Cheoah River, a tributary of the Little Ten-

nessee; and the Blue Ridge reservoir of the Tennessee Electric Power Company, on the Toccoa River, a tributary of the Hiwassee. Their combined effective storage is 280,000 acre feet. Both are operated to regulate flow for the generation of power, but incidentally they furnish some regulation for navigation and for flood control to the extent of the unfilled power storage. The drainage area tributary to both totals only 407 square miles. During the low season they may contribute an additional flow of approximately 900 cubic feet per second to the river, depending on the method of operation."

[fol.1132] In fact, this is entirely true until filled with flood water in the spring, and you get a large amount of incidental flood control from that sort of reservoir even though you do not deliberately operate it for flood control. If you deliberately operate it for flood control, you can do still better. Those reservoirs, however, were built and operated for power reservoirs. I don't assume that they intended to operate them for flood control.

The following questions were asked me and I gave the following answers in the Ashwander case at page 965 of the transcript.

"Q. Now, explain to the Court how these conflicts generally arise?

A. Well, the conflict in a dam attempting to serve quite a number of purposes usually arises from an attempt to use the same storage capacity for two different purposes which are, from the nature of their uses, antagonistic; that is to say, if you attempt to store water for low-water flow and for high-water flow in the same place, or, I should say, for high-water flow regulation and low-water regulation, and have no provisions which can be made definitely for the separation of the volume of water or a separation as to seasonal use of each space, then, of course, sooner or later you are going to run into a situation where you have too much or too little of one or the other; then when you want it for the other purpose you are handicapped.

Q. Now, in making the draw-down in preparation for floods, suppose that the floods don't come, you don't get the excessive high waters?

A. I might explain a little more fully. If we assume that the floods are coming, say, about the middle of March, as

the peak floods do in the Tennessee Valley and hold our reservoir low, that is, trying to use the same volume for two purposes, hold our reservoir until after the flood season is over, then in dry weather we can't fill up our reservoir in order to have the water to use for low-water regulation. On the other hand, if we are trying to use the same volume and attempt to—in order to have low water regulation, fill up the reservoir before we are sure the floods are over, we might get a flood right on top of a high reservoir level and have very little flood space there. Those, in general, are the two conflicts. You have conflicts in pur-[fol. 1133] poses but they generally arise from working at one or the other, either high-water regulation or low-water regulation.

Q. Will you explain to the Court what you mean by "normal pool level"?

A. Normal pool level, in general—well, I think I can say in the case of Norris and the dams on the main river, normal pool level is the top of the storage space of the pool level which would ordinarily be used for low-water regulation; that is, we do not contemplate storing any water above that level for the purpose of low-water regulation. Everything above that would be reserved for flood control storage.' "

In explanation I would like to say that I was talking there about attempting to obtain the use of that storage, 100 per cent efficient for both purposes at the same time. Obviously, under that assumption you are going to run short on one side or the other. And with more study of the flood control problem and the interesting changes going on in it, in the last few years, I think that engineers in general are pretty well agreed that it would be obviously unsound to attempt to obtain 100 per cent for both purposes, when you can obtain a large amount of either one without a substantial handicap to the other.

I was asked the following questions and gave the following answers in the Ashwander case, page 969:

"Q. Just explain briefly to the Court the use of a draw-down on the approach of floods, when you receive notice of a flood approaching; take not only Norris, but take Pickwick, for example, lower down?

A. Of course, in Norris the reservoir—well, the reservoir is so large and the drainage acre relatively so close to the

reservoir that on conditions of very heavy precipitation you could not draw down; you have got to make your draw-down at Norris, in other words, during the low-water season, and keep it down until after the floods are over. That applies to the low water storage space.

Q. And that is to be distinguished from dams that are on the main river, say from Cairo?

[fol. 1134] A. Yes, on the main river. They can be operated, and according to my idea, they will be operated to a considerable extent the same as Norris; that is, you have 5 feet below the normal pool level which you can draw down for low-water regulation.' "

I was asked the following question and gave the following answer in the Ashwander case at page 987 with respect to Wheeler and Pickwick Dams:

" 'Q. Now, had you been interested primarily in power, would you have picked out those stretches for ready improvement?

A. I think probably that I would have picked out Wheeler, for various reasons. I would not say whether I would have picked Pickwick or not, if I had not been primarily interested in power.' "

I was asked the following questions and made the following answers at page 1005 in the Ashwander case with reference to Pickwick:

" 'Q. At the Pickwick Landing site you have got 11 feet additional—

A. No; I think it is six feet.

Q. I am just quoting Mr. Barker about that.

Mr. Fly: Mr. Wheeler, Mr. Johnston.

A. I will have to look that up. I think it is six feet.

Q. In any event, it is less likely to be drowned out by the flood circumstances below with the additional elevation?

A. Yes, sir.

Q. And with the additional head?

A. Yes, sir.

Q. And at a slight additional expense?

A. Yes, sir.

Q. So the construction that you have put there does give the maximum head and the maximum production and electric energy as between the two sites?

A. That is correct.' "

I would like to say in explanation that that was with reference to alternative sites which were investigated. The one [fol.1135] at Parkers Landing which is eight or nine miles upstream and one at Pickwick Landing, which was finally built. According to our analyses, power could be produced more cheaply at Parkers Landing. However, it would have meant a low navigation dam between Pickwick Landing and Parkers Landing in order to overcome a drop of about 8 feet between the two sites. However, the TVA spent some more money on the Pickwick Landing site, even though power could have been produced somewhat cheaper at the Parkers Landing site, in order to eliminate that low navigation dam. Mr. Johnston asked if that gave more head for power, which is true. That is what Mr. Johnston referred to. But on the other hand, it would cost more per kilowatt hour to produce that at Pickwick Landing site.

I was asked the following questions and made the following answers at page 1012 in the Ashwander case, dealing with that subject:

" 'Q. You were asked also whether or not this would be the most desirable combination of units from the standpoint of the production of power. You were asked that on direct examination?

A. No, that would be the most——

Q. The units that are now under construction, whether they would be the most desirable method for the latest production of energy?

A. Well, I was asked if I would have picked those out, and I said, I might have if I had been considering little power projects, and I said I thought for various reasons I would have selected Wheeler, but I wasn't so sure whether I would have selected the Pickwick site or not. I probably would have selected Pickwick if I had been interested in the ownership of Wilson and wanted to benefit that existing property from the power standpoint. That might have been sufficient cause to make me select Pickwick from the power standpoint.

Q. And the result of this will bring about an increase in prime marketable power from some 55,000 KW, to approx-

imately 202,000 without taking the steam plant into consideration?

A. That is correct' ”.

[fol. 1136] One element in the last answer, I might say in explanation, was partly to eliminate the difficulties to navigation below Wilson Dam. Wilson Dam was constructed under the National Defense Act, and to get the full benefit of the operation of that property without interference with navigation below Wilson Dam requires a pool down below so that in the Sheffield Cut the power fluctuations from Wilson do not interfere with navigation in the rather shallow cut. Particular reference there is made to improving the power facility at Wilson, which was built under the National Defense Act.

I should think Wilson Lake would be somewhere between a mile and a half and two miles at the widest point. That is simply an opinion. I judge that from the fact that the dam is approximately a mile long, and I know there are some points in the lake which are wider than the dam is long.

I stated in the Ashwander case, referring to draw-down and conveyors at Norris, as follows:

“This, in general, is the range in which we expect to operate the conveyor system, although I doubt whether the range would go up to 1034 because that would imply as big a flood as we have on record and barges would scarcely be out on the lake during a storm which would contribute any such flood.”

In view of everything I made in that statement, that such a storm is a storm which is experienced perhaps once in a lifetime, in general terms, it might be such a storm, that there would be no navigation out on a lake at that time. That is, it would not voluntarily go out on the lake. That is assuming, of course, that an extremely high wind might accompany such a rainstorm that would produce that sort of flood.

I was asked the following question and made the following answer at page 1016 in the Ashwander case:

[fol. 1137] “Q. The question is market, is it not?

A. Well, of course, obviously you would have to have a market for the power. There is no argument about that.”

I was also asked the following questions and made the following answers:

“Q. Then, you have not posted yourself as to the probable program of the Tennessee Valley Authority with relation to the acquisition of transmission and distribution systems, and the entry into long term contracts for the marketing of power?”

A. I know in general what definitely has been done. I don't know of any of the future plans. I know there was an attempt to serve Knoxville, and I know they are serving Tupelo.

Q. Have they called on you to make estimates as to increase in power capacities with a view to its disposition and to the marketing of that power?

A. No, sir. The only thing I have been called on for in that regard is to say—now, assuming that at such and such a time so much energy. How many units will that take at this plant, or at that plant, or something else. I simply answer the question that is put up to me. I make no prediction as to the time that might be done, or who it might be done by, or anything of that sort.’”

I was also asked the following questions and made the following answers, which I think were a little optimistic:

“Q. Mr. Bowman, in your testimony you referred to the question of improving the plants at Muscle Shoals by the characteristics that you mentioned. Your reference was solely to the increasing of the power capacity?

A. Yes; that is, particularly increasing the power capacity and making Wilson Dam that much more valuable to the Muscle Shoals lay-out.

Q. Well, from the standpoint of power?

A. It arises from increase in power capacity.

Q. Yes. Now, in giving estimates as to increase in capacity from 50,000 or 55,000 k.w. to 90,000, you expressed that in terms of continuous power, did you not?

A. Yes, sir.

[fol. 1138] Q. Now, what would that have on the average load factor of the region—say on a 50 per cent load factor basis?

A. Are you speaking of Wilson alone now?

Q. Well, your figure 90,000, I believe, included the inter-connection, did it?

A. No, the figure 90,000 did not include the interconnection.

Q. All right, that is the 202,000?

A. Yes.

Q. Well, the 90,000 is the work of and referring to Wilson alone?

A. That is right. On a 50 per cent load factor that would be 130,000 kilowatts, and the installed capacity at Wilson is 184, so you could carry that all right.

Q. In other words, Wilson alone?

A. That is, you could only peak it providing Pickwick was built so as to eliminate the navigation restrictions?

Q. Yes, we understand that, but on a 50 per cent load factor basis it would carry the existing units to capacity?

A. Yes.' "

I was also asked the following questions and made the following answers:

" 'Q. Fifty is the average load factor of that region, is it not?

A. The curves of the Alabama Power Company, which I have examined are around 62 per cent, I think, on those which I have had access to.

Q. You mean for the system as a whole?

A. Yes.

Q. You don't know what it is in that area?

A. No, I do not.

Q. Now, in the same way, what would be the 50 per cent load factor applied to the 202,000 k.w. resulting from the interconnection?

[fol. 1139] A. Of course, 50 per cent load factor applied to that would be 404,000, but with the capacity which would be installed you could not carry that load, that is, the capacity which we are contemplating at the present time.

Q. Well, that would be at least 300,000 k.w. with only one turbine installed at Wheeler Dam, wouldn't it, on a 50 per cent load factor basis?

A. Yes, although that would depend somewhat upon the shape of your peaks. You could carry some peaks at Norris throughout the year if you had a very slim, sharp peak which didn't require much water. On the other hand if your peak was say a 5-hour peak and very high, that would be too much to carry on Norris, because you are saving

there for low water operations. In other words, it depends on how much water you would have to use to carry that peak, how much capacity you would have on the system. You would have to set up a load curve before you could tell.

Q. Now, in your testimony as to giving those figures you are referring, of course, at all times only to the water power and not taking into consideration the steam plants?

A. That is correct.

Q. And taking into consideration the steam plant have you estimated how much it would have to operate, I suppose in terms of KWH, in order for the plant in its existing condition to be brought to a 90,000 KW continuous as a whole?

A. You mean for Wilson in its existing condition?

Q. Yes, for an average year and for a low year.

A. You say how would it have to operate?

Q. Yes.

A. Well, that would have to operate on storage from Norris.

Q. No, I mean with the assistance of the steam plant to bring it to the continuous figure 90,000 kw. with the aid of the stand-by plant?

A. You mean how much increase you would have over 90?

Q. How much would you have to operate the steam plant in order to have it, carry it from 50 to 90 in an average year and a low-flow year?

A. You wouldn't have to operate the steam plant any.

A. (Continuing.) Oh, without Norris?

[fol. 1140] Q. Yes.

A. Oh, I thought you said with.

Q. No, as it stands.

A. I believe I have some such figure, sir, I will see. No, I don't have the figures with me on the number of kilowatt hours which the steam plant would have to turn out to bring it to 90,000. Essentially you would have to operate that through the summer season, that is, approximately—well, I say through the low water season, approximately five months, you would have to operate that steam plant from nothing to—well, now, that depends upon what peak you are trying to carry, how much you would have to operate the steam plant. That again depends on what load curve you assume. If that is a continuous basis, why then you can

obviously see that the steam plant would have to be turning out 40,000 at the time that Wilson was releasing at 50,000.' "

(At this point the following occurred:)

"Mr. Fly: During the recess I consulted our budget officers of the Authority in Knoxville regarding the matter of the hearings before the Appropriations Committee on last Monday, which were referred to in Mr. Jackson's cross examination.

I am informed by our budget officer that the figure which Mr. Jackson alluded to appears in the confidential budget report which was supplied to the Bureau of the Budget and the members of the Appropriations Committee, and which provides a preliminary basis for the Appropriations Committee hearings. When I say that these budget estimates are confidential I mean that the House Appropriations Committee holds them to such use and disclosure as it may direct. The particular figures mentioned by Mr. Jackson were compiled from data prepared a year or more ago, which was not checked with the Engineers responsible for the latest controlling data. I am told that the Budget officers were not aware of the earlier figures having been succeeded as a result of the constantly evolving process, and the study and development of the plans for the dams. I am also informed however, that the committee were informed that the figures submitted were approximate and tentative and that they were subject to correction, for that reason.

In order that there may be no further misunderstanding I have requested the Knoxville office to send me a copy of the table from the Budget estimates from which Mr. Jackson's figure appears to have been taken. I should like to note again that is the table contained in the budget estimates supplied by the Authority to the Committee, and which by the direction of the Committee are held confidential until released.

[fol. 1141] Mr. R. T. Jackson: I don't agree with that statement, but if there is any answer necessary we will file it tomorrow.

Mr. Fly: We incidentally will prove that, so there will be no question.

Judge Allen: The Court will make no ruling on that at this time."

In the diagram, figure 3 on page 201 of my article in Civil Engineering for April, 1935, (offered and received in evi-

dence as Complainants' Exhibit 904) on which the horizontal scale is designated as "Reservoir Storage Capacity in Thousands of Acre Feet", and the vertical scale as "Water Surface in Feet", I show elevation 962 as the minimum draw-down. That is what the diagram shows. The diagram also shows all of the storage below elevation 962 as dead storage. I also show an elevation of 1020 and have labeled all of the storage between elevation 962 and elevation 1020 as "Power Storage". I also show the elevation 1034 above the elevation 1020 and have labeled all of the storage between elevations 1020 and 1034 as "Flood Storage". I would like to say in explanation of that, at that time it was my personal designation of those various things, without having been with the TVA long enough to give the subject particular study, and that should have been very much qualified. It is not an official opinion in any way, and was purely a personal opinion. At the time this was written I had not been with the TVA but a year. This publication is dated in 1935 and I prepared this article late in December 1934, and came with TVA about the first of November, 1933. I testified in the Ashwander case before this was published, but not before it was written. I would like to state further that investigations which I have made, and which have been made by the TVA since that time, show that in a great many respects this particular figure is essentially inaccurate.

[fol. 1142] I would like to say in explanation of this figure 2, (offered and received in evidence as Complainants' Exhibit 905), taken from my article, that that simply shows the amount of storage required to fill in the depressions in flow at Florence, Alabama, and has nothing whatever to do with the storage which is contemplated, or the dam sites which that storage might be made available at. It simply shows the requirements without reference to reservoirs. It says "Storage Required". It shows how much storage has to be added to the low water level in order to produce the flows shown on the vertical side of the graph, and the bottom of the graph shows the storage. It also shows what Norris and Wheeler could do under certain assumptions of operation. Other assumptions could be made which would show entirely different results.

The following is a correct reading from the TVA Report to Congress of March, 1936 (Complainants' Exhibit 328) at page 59:

"The following table illustrates the effects of water regulation in increasing prime power capacity of main river plants. It is assumed in this table that the nine dam system on the main stream has been completed, and that the Norris, Clinch River and Fowlers Bend, Hiwassee River projects are in operation on the tributaries, but no account is taken of the power that could be generated at these tributary reservoir projects themselves."

It simply illustrates, but is not a table showing, what will be done. It simply shows what could be done, in that it is illustrative of this point.

I am familiar with the table showing the continuous capacity of the integrated TVA system of 660,000 kilowatts and an annual primary output of 5,780,000,000 kilowatt hours. I cannot give you the amount of storage in acre-feet which we have to have in our reservoirs to produce that [fol. 1143] much power in a dry year like 1925. I don't know it off-hand. I cannot tell the elevation that Norris and Fowler Bend Reservoirs would have to be at in such a year on February 1st or March 1st in order to have enough storage to meet this amount of power requirement.

On direct examination I testified that the total controlled flood storage in the ten dams in the TVA Unified Plan, excluding Fontana, amounted to 8,925,000 acre feet. The exhibits previously submitted show how much of this capacity is at the various dams. The figure is merely a summation of items in those exhibits, plus something for Wilson. If you would add 43,000 acre feet for Wilson, that would come out to that total. I included 2,020,000 acre feet for Norris and 362,000 acre feet for Hiwassee. In order to have 2,020,000 acre feet available at Norris, it would have to be at elevation 955 or 960. The volume curves will show whether Norris would have to be at the maximum draw-down level. Yes, it is 955. That is not necessarily the maximum draw-down level. That has not always been reported before as the maximum draw-down level that I know of, except that I had indicated that in this diagram of mine which I said is now incorrect. Elevation 955 may have been reported to Congress as the maximum draw-down level, but I am not sure. I don't think it is true that that necessarily represents the maximum draw-down level.

If you had 2,020,000 acre-feet at Norris above the 955 level that would take you to 1,034. The chart shows that

if you had it filled to 1020 in order to provide storage for low water season, there would have been less than 500,000 acre-feet left between the point to which the reservoir was filled and the 1034 or crest level, but the assumption is not in accordance with the facts.

[fol. 1144] I am not in charge of the operation at Norris and cannot give you the figure as to how much of the capacity of 2,020,000 acre-feet of flood storage would be available to impound the floods on December 1st, January 1st, February 1st, March 1st, April 1st and May 1st. I did not give the Court the figure including 2,020,000 acre-feet as available flood storage in ignorance of whether the operating men who know about it would have the reservoir filled at the first of these months, perhaps up finally at least to the 1020 level. I had the assurance that on January 1st or say near the beginning of the flood season the reservoir would be drawn down at least to elevation 955 or 960. What happens in between in operation is up to the operating men. I have seen the statement of Dr. A. E. Morgan to Congress appearing in the exhibits here in evidence that the elevation of Norris would be up to 1010 somewhere around January 1st, but I don't know where it comes from, and there might be an error in that statement. I do not recollect the statement of Dr. Morgan in which he states that the elevation would be up around 1020 by the first of April. It could be up there. It could be operated that way. If it were up there, my statement about the controlled flood storage would not be in error. I do not have a rule curve for the operation of Norris Dam. I am not in charge of operation and that will be produced probably by some other witness.

I am the head of the Project Planning Division of the TVA. I was not with the TVA when the plans for Norris Dam were being matured. The plans for Norris Dam had been fixed before I came with the TVA. I had no contact with the Bureau of Reclamation on their design of the dam. I did not come with the TVA until the 18th of October, 1933, at which time all of the elevations of Norris Dam had been fixed and the plans were well under way. I did [fol. 1145] not have any reports from the Bureau of Reclamation. Later on I was in on some details of the design, but the general drawings had been issued at the time I came with the Authority. I went into the discussion of some things as contraction joints, foundation grouting,

things of that sort, but I did not have anything to do with fixing the dimensions.

There are all sorts of widths in Norris Lake. Perhaps it is not much wider than five or six hundred feet in places. I believe the maximum width, in my opinion, that is cross-ways of the lake, would be between a mile and a mile and a half up in the Loyston area back up in the bay. If you are familiar with the topography of Norris, it is water gaps between ridges. This big pond is one of the largest basins that existed in a tributary. Outside of that I think it would be three quarters of a mile. On the average I should think it would be less than a mile.

(At this point counsel for complainants requested certain contour maps which the witness previously agreed to produce.)

Examination by the Court:

There are in my office upwards of 10,000 maps. A project of this sort involves a great deal of that work and requires a very large number of sectional maps.

[fol. 1146] Redirect examination:

I have made a correction in the table with respect to the Wheeler project (Defendants' Exhibit 43) by adding 70,000 acre-feet to the volume shown in items 5 and 7. It now correctly represents the facts. A one-foot error was made in taking those volumes off of the volume curve.

"Mr. Fitts: We ask permission to substitute this table as defendants' 43 in place of the exhibit that now appears in the record.

Mr. R. T. Jackson: We want the same objection that we were making to the reception of the original exhibit on yesterday, to stand.

Judge Allen: You do not object on the ground it is a correction?

Mr. R. T. Jackson: No. I will ask leave later to ask the reason for its substitution.

Judge Allen: It may be received.

Mr. R. T. Jackson: An exception.

Judge Allen: And your exception noted.

Mr. Fitts: May it please the Court, this is the exhibit we were requested to correct on yesterday, defendants' ex-

hibit 50. Certain figures appeared up here which had not been marked out and the Court asked us to distinguish between Hiwassee, I believe under construction and Norris actually constructed. We would like to put this in the record as defendants' Exhibit 50. That was the only suggestion.

Judge Allen: It may be received.

Mr. R. T. Jackson: Our same objection.

Judge Allen: Overruled. You may have your exception."

In making a statement on cross-examination with respect to the character of the storage which is above the gates at Norris Dam, I meant to state that that storage was comparable to the storage proposed by Mr. Kurtz. I think that my statement shows that it was comparable to a detention reservoir. My reason for that is that this storage will be held in place above the top of the gates with an outflow limited by the head of the water above the top of the gates, [fol. 1147] and in fact that the 20,000 second feet, which I think was Mr. Kurtz' proposal for release from his Norris project, the pool could rise an additional 7 feet and there would be 280,000 acre feet of this detention storage created, which would be held on the surface of the reservoir with a release of what Mr. Kurtz holds. I believe I testified it might be approximately equal to valley storage, but I wish to point out this difference in comparability. Valley storage moves down the stream without any control over it. Detention storage on the surface of the reservoir is held in place with an outflow or a moving down stream distinctly limited by the depths over the gates. In other words, the whole body of that water cannot move down stream as in the case of valley storage.

"Q. Now, Mr. Bowman, when was the site for the Gilbertsville dam finally selected and agreed upon?

A. The site for Gilbertsville dam——

Mr. R. T. Jackson: I object to this, that the site for Gilbertsville dam had been finally selected. It must have been by an appropriate resolution of the Tennessee Valley Authority.

Judge Allen: Is this preliminary to something else?

Mr. Fitts: It is, your Honor, preliminary to questions to bring out matters with reference to investigations and work that has been done at Gilbertsville in the last six months.

Mr. R. T. Jackson: You cannot say that that site has been authorized?

Mr. Fitts: I did not say authorized.

Mr. R. T. Jackson: I objected to that, as to the competency of the witness to testify.

Judge Allen: Objection overruled.

A. After last August, after we had completed our investigation and drilling of the alternative sites, we had a meeting of the Board of Consultants with our engineering staff, and it was agreed at the time that from an engineering and construction standpoint that the Gilbertsville site was the best of any site which we had investigated, and was the site at which the dam should be built."

[fol. 1148] At the time of the Unified Report to Congress of March 31, 1936, the investigation as to sites was still in progress. Our investigation at that time was with reference to three or four sites in that general area, which were all alternative sites, going on at that time. Since the time I furnished information to the Budget Officials of the TVA with reference to the design and plans of Gilbertsville Dam, a year ago, for use in preparation of Hearings on the last Deficiency Appropriations Bill, and during the last six months, early in that period we were still investigating the so-called Birmingham site as an alternative to the Gilbertsville site, and that was going on until some time last August, I believe, which was the last work we did on the Birmingham site. Possibly it ran over into September, to check up a few points remaining open. Since that time we have concentrated on the Gilbertsville site. There have been extensive investigations consisting of core borings, deep test pits, study of the impermeability of the flood planes of the river, and actual tests as to the practicability of driving sheet piling through it, and reports and studies about preliminary designs, which have proceeded with a force of eight to ten men in the office all during that period, and they are still at work.

"Q. Now, Mr. Bowman, as a result of those studies and investigations have any changes been made in any place as to the general layout of the project?

Mr. R. T. Jackson: I object to that as incompetent and irrelevant, as to what Mr. Bowman's plans are. He has no

authority to make plans to be carried out, and his plans are subject to study by the Board.

Judge Allen: He may answer.

The Witness: Will you read the question?

By Mr. Fitts:

Q. I asked whether or not as the result of these studies and investigations any changes have been made in any plans for the general lay-out of the project?

A. Yes. Changes have been made through this period, that is in the way of refinements, studying alternative locations of structures, intensive study of pool levels, conferences with the Board and consulting engineers. In other words, all through this period it has been approaching what is, in the manner that it should be used in determining the final engineering feasibility.

Q. Now, will you tell us over how long a period of time any change in the surcharge level has been under consideration and study?

Mr. R. T. Jackson: I object to that unless it is shown that there is something authorized by the Board.

Judge Allen: He may answer.

Mr. R. T. Jackson: Exception, please.

A. We have made extensive investigations with funds that have been authorized by the Board for that purpose, of various alternative sites, including Gilbertsville, Birmingham, Aurora, Shannon and other sites which we did not do much work on but looked at, for a period of over two years, in which the maximum pool level has, or surcharge pool level has been under study, in order to determine the amount of flood control which could be obtained at a site in that vicinity, and it has been in a gradual process of development."

I remember distinctly of four levels, 362, 367, 370 and 375, even 380 has been under consideration. That is the range that we have been working through. One of the difficulties in building a high dam is in finding a foundation which would be satisfactory for building a dam as high as we wish it. At different times it looked as if it was rather a hopeless proposition to build a dam up to the height we have decided on today, and the foundation investigation, and the determination of the maximum pool

level has been very closely related, as to what we could do.

With respect to the statements appearing in my article in Civil Engineering for April, 1935, I also stated in that same article that the final rules for the operation of the flood control facilities at Norris Dam were still being studied, on page 202:

[fol. 1150] "Final rules for the operation of the flood control facilities at this dam have not been fully developed. Obviously the governing principle will be to allow its watershed to add as little as possible to the peak stages of the Tennessee River."

Norris Dam had been under construction at the time this article was written about fourteen or fifteen months, so that I was writing about a dam that was not in operation and considerable study was still going on. The designs had not been fully completed at that time even.

In regard to my testimony in the Ashwander case with respect to the change in the site of Pickwick Dam, I also testified to the following effect, beginning at bottom of p. 873 of the transcript and going over to the top of p. 886:

"Q. Mr. Bowman, why was Pickwick Dam placed at its present dam site as distinguished from the site at Parker's Landing, 18 miles away?

A. We made extensive studies covering the proper location of Pickwick dam, that is, considering their locations in that general vicinity. It appeared that considering power output alone, we could perhaps produce power, produce energy, I should say, a little more cheaply at the Parkers' Landing site. However, for navigation purposes, a low navigation dam would have been required in the vicinity of Pickwick Landing if the high dam was to be built at Parkers' Landing in order to back water to Parkers' Landing, either with Aurora dam built, or with the natural channel conditions of $4\frac{1}{2}$ feet minimum navigable depths, below Pickwick, that is, there is a stretch between Pickwick and Parkers' Landing which would have required a low navigation dam in the vicinity of Pickwick in order to render that stretch navigable. Parkers' Landing is right in here.

Our considering the fact that the Government under the present set-up would have to build both of those dams, it worked out more economically for the one agency to build

the high dam at Pickwick Landing and accomplish the full navigation of the stretch rather than to put in one low dam and one high dam. This might not have been the situation if a private company had been developing the high dam, and they would have naturally built that there at the most economical point.

In other words, the Government cannot require them to go here and there and somewhere else and build a dam at a certain point just for navigation. So that was the general reason we put Pickwick where we did.

[fol. 1151] Q. You mean by that there is no particular means of getting private companies to improve bad navigation stretches, is there?

A. Yes. Well, I mean as refers to this particular section in here. (Indicating.) Now, as to Pickwick as a whole, while we selected that site, we selected this general locality for the reason that from the head of Colbert Shoals to the entrance of Lock and Dam No. 1, just below Wilson, is the worst stretch in the lower river after the head of Muscle Shoals and Elk River Shoals has been improved by the construction of Wheeler Dam, and naturally we are anxious to eliminate the bottle necks near the lower end of the river, that is, pick the worst stretches first and improve them so that craft could use the otherwise minimum depths which existed after the improvement of the worst stretches.

Q. In other words, roughly the idea is to pick out the—to the exclusion of Norris with its big flood control value—the effort has been to pick out particularly bad stretches so far as navigation is concerned and give priority to those stretches?

A. Particularly bad stretches for their improvement and to make possible the general improvement of a big reach of the river, and particularly at the lower end. It would do no particular good to construct your improvements here above Chattanooga, since you had this bad place below, but if Pickwick is built down here and the Wheeler and the Norris and later on they will give you 6½ foot minimum navigable depth into Chattanooga and anything beyond that might come later.

In other words, the improvement of this section is the improvement of the bottle neck."

The facts stated there are true and the matters of opinion expressed there still represent my opinion.

I also testified in the Ashwander case with respect to the operation of Norris Dam for flood control and low water regulation on p. 944 of the transcript as follows:

'Q. Now, what do you consider an appropriate means of alleviating these irregularities of stream flow and the consequences which you have mentioned?

A. Of course, as far as the floods go, among the possibilities that exist in general for flood control or regulation, or about the only thing in which we can do in the Tennessee Valley, is to regulate these floods by means of storage. As far as navigation goes slack water, maybe of some sort, appears to be about the best and only solution.

[fol. 1152] Q. And you consider Norris Dam such a project as would be useful in those regards?

A. Yes, I do.'

By Mr. Fly:

'Q. I also ask you whether you testified to this effect, appearing on page 992 of the transcript of your testimony in the Ashwander case?

'Q. Now, Mr. Bowman, if you were instructed to improve navigation on the Tennessee River, reduce flood waters in the Tennessee River basin, and reduce flood waters in the Mississippi Valley basin, by work on the Tennessee River, could you suggest any combination of structures which would permit those functions as economically and effectively as high dams in the main stream of the Tennessee River such as Wheeler and Pickwick, operating in conjunction with storage dams in the tributaries of the Tennessee such as Norris Dam?

A. No, I cannot think of any structures or combination of structures which would accomplish those multiple purposes as well nor as economically. I doubt whether any system of structures could be designed which would accomplish those purposes as effectively as what you have now. I think your general set up would be essentially to the accomplishment of those purposes.'

Did you so testify in that case?

Mr. R. T. Jackson: I object to that, because it has no relevancy to anything that I questioned the witness about in the transcript.

Mr. Fitts: It certainly does.

Judge Allen: The objection is overruled. You may have your exception.

Mr. R. T. Jackson: Exception noted, please.

A. Yes, that was my testimony.

Q. Does it still represent your opinion?

A. Yes."

The TVA dams on the main stream are located approximately at the sites selected by the Army Engineers for the high dam plan in House Document 328. There has been some variation; I think the maximum is around thirteen miles, but it is the same general region. With other sites it is exactly the same site as far as we could determine. To the best of my knowledge, the seven dams now recommended for construction by the TVA on the main stream of the Tennessee are the minimum number of dams necessary to ob-[fol. 1153]tain a nine foot navigable depth from the mouth of the Tennessee River to Knoxville. There are definite limitations in two ways. One is the availability of feasible dam sites on the Tennessee River. The foundations particularly below Pickwick and above Wheeler are so poor in most cases that you have a very limited number to select from. The other limitation is the presence of large cities and other facilities in the reservoirs which are almost prohibitive, if you would come to the point of attempting to substitute a much higher dam for any of those which we have now planned, that is you are getting too seriously to Decatur or too seriously to Gunter'sville or too seriously into Harri-man or Kingston, or Knoxville, too seriously, if you went higher at those points than what we have gone. Both of those factors, of course, impose a rather definite limit on the minimum number of dams which you can use, and I think we have gone to the full extent of those limitations.

I believe that Norris Dam is on the same site on the Clinch River as that tentatively selected by the Army Engineers in House Document 328, at least as to one abutment. It is on the same site as drilling was being done at the time the Authority took it over. I am not absolutely sure about the other, about both abutments in House Document 328. Hiwassee is located, the dam itself, on the other side of Fowlers Bend from the Coleman site which was the site proposed in House Document 328. The Coleman site did not have the storage, and it had power, a power tunnel through

the bend, with the power house approximately at the same site as the space provided for the power house below the Fowlers Bend Dam, on what we now call the Hiwassee.

I think I am correct in saying that in all cases where there have been departures in the location of sites from those tentatively selected in House Document 328, these sites have been moved down stream. This has largely been [fol. 1154] for the reason that more suitable foundations were found downstream. For instance, Gilbertsville has been moved downstream. Pickwick is at the identical location. Wheeler is at the identical location. Guntersville has been moved either 12 or 13 miles downstream from the site in House Document 328. Chickamauga has been moved one mile, and Watts Bar about 12 miles, or 13, and Coulter Shoals about 4 miles. This had the effect of course of increasing the flood control storage, that is you lengthen the pool at the lower end. That enables you to take advantage of the actual and possible increase in flood control storage without changing the pool level. That has been a general result of that.

“Q. Have any other results followed from the location of Guntersville Dam and Coulter Shoals site and Watts Bar site further downstream from those tentatively selected?

A. In nearly all of these cases the pool level has been maintained at about the same elevation, that is of the next dam downstream. So if we move a dam downstream into the pool of the next dam, it means that the site is at a wider and deeper point in the next pool below, which gives a better navigation depth in that it avoids in some cases as much as four or five miles of dredging in order to get navigable depth. And of course that means that instead of a channel of that length, 300 feet wide, and having about the governing depth all the way through, we now have a channel which may be of that width immediately below the lock, but downstream from that a few hundred feet it rapidly widens into the pool, and it increases in depth. So in general that has resulted in a better navigation facility in the heads of the pools.

Mr. R. T. Jackson: I move to strike out the statement of the witness ‘resulting in better navigation facilities.’ I think he can give all the hydraulics, depths, widths, but

whether that is better navigation, the witness is incompetent to state.

Judge Allen: That is your opinion?

The Witness: Yes, your Honor.

Judge Allen: It may stand. You may have your exception. The statement may stand as an expression of the witness' opinion.

[fol. 1155] Mr. R. T. Jackson: May our exception be noted on the ground of the incompetency of the witness to testify as to that.

Q. By saying better navigation facilities, I presume you mean a better physical navigation channel?

Mr. R. T. Jackson: The same objection.

The Witness: A better physical navigation channel.

Judge Allen: The objection is overruled. You may have your exception."

The general effect on the production of hydro-electric power of locating dams with overlapping pools is that that does not increase the head in particular, in a system of dams or in a chain of dams, because you are not affecting the tail water below the last one, nor the head water above the first one. There may be minor differences due to fluctuations in the pools, but in general the total gross head on the system is not changed, of course, except it may be changed slightly, a little bit, hold it up at the last one, or the upper one, if this involves a slight change in pool levels, perhaps.

"Q. Now Mr. Bowman, does the general layout of Wheeler Dam substantially conform to the Army plan as tentatively set out in House Document 328?

Mr. R. T. Jackson: We object to this as not proper re-direct examination.

Mr. Fitts: You went into the very question of the location and nature of Wheeler and Pickwick Dams on cross examination.

Mr. R. T. Jackson: I don't think so, Mr. Fitts.

Mr. Fitts: I think you did.

Judge Allen: He may answer.

Mr. R. T. Jackson: May we have our exception, please.

A. Yes, it conforms quite closely to the general layout in House Document 328 as to arrangement of structures, as to

pool levels, except we were not able to use the same surcharge pool level on account of excessive damages in Decatur, when we got into a study of that. The power capacity perhaps is somewhere between 90,000 and 100,000 kilowatts greater in the House Document 328 plan than what we have provided for."

[fol. 1156] It generally conforms to the plan for which the lock was being built by the Army Engineers at the time the TVA Act was passed.

I was asked on cross-examination about the figure 3 that appeared in my magazine article illustrating volume capacity at Norris (Complainants' Exhibit 904). The volume which is marked "Power Storage" is also valuable for flood control and for other purposes. That is one of the reasons I stated that that figure did not now represent my opinion, and that my opinion has been changed by the exhaustive studies which have been made by the TVA since that time.

"Q. Mr. Bowman, I ask you to state whether the elevations given for the so-called power storage on that figure was intended to indicate that this storage could not and would not be used for flood control?

Mr. R. T. Jackson: Just a moment. I object to that question.

Judge Allen: He may answer. The objection is overruled.

Mr. R. T. Jackson: Exception noted, please.

Judge Gore: Now, he is talking about the figures in his article?

Mr. Fitts: The figures in his own article, which they abstracted from the article and photostated, and they were offered in evidence.

A. My principal intention in making the subdivision on that diagram (Complainants' Exhibit 904) was to show the storage which was explicitly and separately reserved for flood storage."

(Thereupon counsel for defendants called the attention of the Court to the following statement by Dr. Morgan on p. 374 of the Hearings on the Second Deficiency Appropriation Bill 1937, Complainants' Exhibit 116):

" 'Dr. Morgan: The operation of Norris Dam differs substantially from that of Wilson Dam or the Wheeler Dam.

Norris Dam will be held at low elevations during the winter and during the first part of the flood season, so that the storage it gathers for power purposes will also be valuable [fol. 1157] for flood purposes. That is, during the fall, we run the water down low and use up the power storage, and we hold it down there during the season when floods ordinarily occur, so that the same storage capacity that is good for floods is also good for power to some extent. During the latter part of the high water season we close the gates and store the stream flow. A flood may occur and furnish part of that water supply. If not, the ordinary flow will do so.

Then about the first of April the reservoir will be filled to the summer storage level, because we are almost sure that there will be no excessive floods later than that.

Mr. Taber: That April 1 figure is about what elevation?

Dr. Morgan: 1020. From the spillway level up to the top of our gates—that is, from 1020 to 1034—there are 525,000 acre feet, but from 1020 up to 1055 there are a million and a half acre feet; that is, at the extreme high level.' "

The table (offered in evidence as Defendants' Exhibit 53) shows the volumes of the TVA main stream reservoirs at various elevations. To the best of my knowledge, it is correct. I checked it last night. I prepared it myself. The definitions and statements of fact are correct to the best of my knowledge.

"Judge Allen: The Court thinks that complainants should have the opportunity to check this before it is ruled on, as to its admissibility."

Recross-examination:

It is my opinion that the TVA in planning to construct seven high dams on the main Tennessee River planned a minimum number of dams practicable. As a theoretical proposition, if it were practicable for one to build a single immense dam at the mouth of the river so as to concentrate the entire fall of the river at a single dam, that would produce the largest amount of power that could be produced [fol. 1157a] from that stream. If it were not practicable, as it usually is not, to build a single mammoth dam at the mouth of a stream so as to concentrate the entire fall of a stream at a single point, it is true that the next most

effective method that you could adopt to develop the maximum amount of power from that stream would be to build the minimum number of high dams which it would be practicable to build upon that stream to develop its entire fall. That is correct as to power and a great many other purposes.

I stated that any changes that we made in sites of these high dams which are described in House Document 328 were in the direction of moving the sites downstream. The effect of moving the sites downstream may have been a small increase in head. Of course that would depend upon the condition of the flow. If you had a lot of pondage there, it would also increase the amount of low water pondage which could be used for various purposes.

By Mr. R. T. Jackson:

"Q. Well, as a matter of fact, while the degree would vary any time you moved the dam downstream, in order to keep the upper end of the pool at the required head, you would require a higher dam, and the result necessarily would be a somewhat greater head; isn't that so?

A. No, the result would not be a greater head if you maintained your pool level, which would be also at the same elevation, and simply to slide the dam downstream into that pool, you do not gain head, except at certain times during floods you might get a little less backwater, something of that sort."

If you had a dam site set out in House Document 328 with [fol. 1158] an elevation of its pool at 500 feet, to take an arbitrary figure, and you moved the dam downstream, there would be somewhat more volume. That is correct so far as the one dam itself is concerned. The result would be, as to that one dam, that you would have a higher dam and somewhat higher head.

I said that the layout at Wheeler was the same as the site, plan of dam, and location of structures as the Army Engineers were proceeding with when the TVA took it over. I know that the Army Engineers had a space provided in which intakes were to be built in Wheeler Dam for future power development. There were intakes being built which were enclosed by removable bulkheads. They were not being built, they were in the preliminary designs for the de-

sign of the dam, that was contemplated at that time. There was no setting for turbines, but there were intakes for future turbine settings.

Examination by the Court:

An intake setting is the passageway through the dam where the power house could be built below and put in use, with this passageway so that they would not have to cut a hole through the dam in the future, so that the space was provided, and that space could be closed according to the preliminary plans by the use of temporary bulkheads which could be removed at the time the power house was erected.

Recross examination continued:

I testified on my re-direct examination that the various storage capacities which I figured on top of Norris Dam were comparable to Mr. Kurtz' detention reservoirs rather than the valley storage. I understood that there were gates on the detention reservoirs proposed by Mr. Kurtz that closed as the head went up and kept the discharge as a predetermined amount, in addition to the one or two free [fol. 1159] openings. That corresponds exactly to the limitation placed on the outflow from this storage by the spillway gate. In other words, they both have a limited outflow capacity. The only limited outflow capacity that I show on top of the spillway gate is dependent on how high the water may rise above the spillway gates. But, for a certain volume in the flood, it can only fill so high. I do not believe there are enough conditions stated as to the valley so that I can answer the question whether if you have storage through a swampy valley of a certain size, a certain size flood can only fill the valley so high.

Referring to the change made in Defendants' Exhibit 43 with reference to the Wheeler project, in going over the storage volume curves to pick out the figures which I supplied, I found out I had taken the wrong line in reading across for Wheeler, and that gave me the check in which I found I had read a foot too low when I furnished the information before, and which I corrected. I did not check any other report prepared for the TVA. I found definitely where I had followed through and made the wrong figure, and I checked that against the tables that had been in exist-

ence for several years, and going back to them I found they check with the diagram, and it was simply my misreading the night before when I prepared that. I know nothing about whether my failure to change item 9, controlled flood storage of 490,000, would leave it in conflict with the TVA report. I checked that at elevation 556, as you can readily see, which was wrong on the exhibit which I submitted. That can be told, I think, from information that you have available, that it was 70,000 acre feet at 556. That flood control storage was stated and remains the same. You can [fol. 1160] check the difference between those and find the figures all check perfectly for the flood control storage of the reservoir.

The present site of the Gilbertsville project is 22.7 miles upstream from the mouth of the river. I think that is correct. It might be 22.6 or 22.8. I can not say whether the location that has been reported to Congress for 1936 and 1937 has been 22.5 miles. You are correct in understanding from the table, p. 123 of Complainants' Exhibit 115, that the site for Gilbertsville is shown to be 22.5. If I am not mistaken, that is the location of the Illinois Central Railroad bridge, and our explorations extended from the location of the Illinois Central Railroad bridge upstream a distance of, I would say, a quarter of a mile, and I believe the base line, as we finally shifted it in that area, comes at 22.7,—it may be 22.65. It is correct, however, that the statement on page 37 of this report shows 22.5 from the mouth of the river. I think that was the downstream line of our explorations, but the base line upstream was about three-quarters of a mile.

The initial power installation at Hiwassee is 60,000 kilowatts. I know that the TVA has contracts for the sale of firm power. I am familiar with the ferrying operations of one of the railroads down at Guntersville. I am also familiar with the fact that as soon as the TVA project is completed, in about two months, they will have to use the TVA locks, they will have to break their tows for the first time in 25 years with the present size equipment.

I have sworn to the best of my knowledge this Defendants' Exhibit 53, which we are going to re-enter, is a correct exhibit. We got it out last night under pressure. There may be some arithmetical errors which I will be glad to correct. You call my attention to the fact that the two elevations [fol. 1161] at Guntersville are 593 to 594; Chickamauga

575 and 584; Watts Bar 536 and 540 so that the elevations are getting lower as one goes upstream. That is an obvious mistake by me.

Redirect examination:

In this illustration of Norris Dam, which is the frontispiece on the Report of March, 1936, to Congress, the photograph shows almost the entire face of the Norris Dam with the crest gates raised. I presume it is approximately to elevation 1034—it looks as though they are fully up, which is during construction. The method by which this storage above 1034 will operate as a detention basin is that a flood of a certain volume comes down the river above Norris, obviously to raise to any given elevation above the crest of these gates, assuming the water is filled to the top of the gates at the beginning of the flood, is based on this, that the water cannot rise higher above the gates than the relation of volume of flood to a similar volume in the reservoir. According to hydraulic experiences, that limits the outflow through the gates to a definite amount. Those gates are each 100 feet long, or a total length of crest of 300 feet. We have the space all the way up to the crown of the roadway, which is elevation 1061, in which water could impound behind the dam. Of course beyond that it could not go up and up without overflowing the dam and causing serious damage, perhaps.

The general principle of operation there is very much the same as though you had outlets in the base of the dam which had no gates in them, or which had gates, which are automatically controlled. The only difference being that with automatic control on certain gates, perhaps you could hold them to a constant flow but if you had certain conduits in the bottom of the dam without gates, the flow through those [fol. 1162] would increase in proportion to the square root of the head. As the water built up above the dam and over the gates, the outflow would increase three halves power. In other words, the outflow is the effect of the increase.

Except for a length of 300 feet, we have nothing but dam up to the top of the roadway. That places a definite limit on the length of the dam, up to the top of the roadway, over which the water could flow. The only way water could get out is through those openings in the middle. That is of limited capacity. In order to get out any other way, it has

to get over the top on the roadway, except as to the sluiceways in the bottom, and up to the capacity of those it could flow through those.

Examination by the Court:

The gates themselves have a height of 14 feet. The elevation 1020 is the bottom when the gates are raised and the top when lowered. The top of the gate is approximately at 1034. From the roadway down, it is entirely open. There is 100 foot width between the piers and three openings. If the water is up to the roadway, then if the sluiceways and so on are opened up, the dam will retain the water, except for such water as goes through the three openings just under the roadway and between the piers.

Recross-examination:

That is somewhat the same effect as if your valley spread out into a swamp and then comes into a narrow neck, and the narrow neck limits the flow, and the flood backs up into the swamp area. If that has the same arrangement as the [fol. 1163] capacity and outlets, all that sort of thing, then of course it would be about the same. That is, if you had a swamp the same size as Norris, with a bottleneck at the lower end of about the same size as these openings, you would have this same condition, but there is a definite limit on the outlet which ordinarily does not exist in nature. Of course, if you had a ledge of rock, something like that which made a weir across the valley, you would have something comparable. I can't tell how many feet under water LaFollette, Tennessee, would be by the time we got this water up to 1061. It would be into the low parts of LaFollette. I don't know how high up. I can't answer exactly whether LaFollette would be 11 feet under water pretty well throughout. LaFollette goes a considerable distance up along the mountainside. There are parts of LaFollette which would be submerged. A great many other things would be submerged around Norris.

Redirect examination continued:

I stated on cross-examination that by moving the dam site down stream, if you are dealing with an individual dam, some slight increase in head would result. The same condition would not obtain, of course, with a continuous series

of dams with overlapping pools, because you could not obtain the greater drop from the head of the first dam down to the tail water of the last dam in the series by moving any intermediate dams either upstream or downstream. You would have the same gross head, regardless.

Recross-examination :

I did not promise to produce the TVA Board resolution in connection with the Hiwassee Dam levels. Of course, I cannot produce the resolution you are asking about. I said I [fol. 1164] would make an attempt to calculate the comparison of time at which the normal pool level would be maintained in each of these main river dams. I did make some attempt to calculate it and I simply could not arrive at any figure for that because it depends upon so many factors that I was simply not able to make the assumptions and combine them in a way which would give any result. I have not formulated operating rules myself. I simply know that there will be fluctuations between those. The trouble is it depends on the health and medical section, on their set-up for fluctuation for malaria control, and on the operations of Mr. Woodward for low-water release, and that sort of thing. I didn't have the figures of all those different people so that I could combine them, and I don't know whether they could be combined mathematically. I know in general how the malaria control people intend to fluctuate those pools from descriptions which they have written and specifications they have set up. I stated approximately the variations in those pool levels at certain dates yesterday, but as to the fluctuations in between, it is just sort of a jig-saw, which will depend on the flow of the water in the stream, depending on the season. I have not seen any rule curves or operating rules from the power section. I think this entire operation of those pools is set by Mr. Woodward from time to time.

(The witness was excused.)

[fol. 1165] At a subsequent session of the Court, JAMES S. BOWMAN was recalled as a witness, on behalf of the defendants and, having been previously duly sworn, was examined and testified as follows:

Direct examination:

I prepared the document (offered and received in evidence as Defendants' Exhibit 54) and it is correct to the best of my knowledge and belief. I corrected on it the elevation figures which were pointed out as in error this morning on Defendants' Exhibit 53 and the figure for Coulter Shoals I have added and it is tentative because we do not have the surveys completed yet on that project.

(Counsel for defendants then offered in evidence the maps of the TVA reservoirs which were produced by the witness pursuant to the request of counsel for complainants—Chickamauga reservoir as Defendants' Exhibit 55, Watts Bar reservoir as Defendants' Exhibit 56, Coulter Shoals reservoir as Defendants' Exhibit 57, Norris Reservoir as Defendants' Exhibit 58, Hiwassee reservoir as Defendants' Exhibit 59, Gilbertsville reservoir, dated April, 1936, as Defendants' Exhibit 60, Pickwick reservoir as Defendants' Exhibit 61, Wilson reservoir as Defendants' Exhibit 62, Wheeler reservoir as Defendants' Exhibit 63 and Guntersville reservoir as Defendants' Exhibit 64.)

"Mr. Fly: I believe all of these, your Honor, are at stated elevations in feet, but the particular stated elevation does not precisely conform to other figures. They are taken from different dates and that sort of thing, but they do purport to cover the reservoir area at the particular elevation indicated thereon.

Mr. R. T. Jackson: As to exhibit 59 for Hiwassee we object only that the map should be changed to show the pool elevation for the reservoirs shown on the map. It shows no pool elevation but I assume that can be put on, and we think that should be done before it is received.

[fol. 1166] Exhibit 60, Gilbertsville Reservoir, we object upon the ground that the reservoir should be shown in color, or outlined so that it can be followed accurately. As it is, the reservoir not being colored, and the line is so dim and obscure that it is impossible to follow it. In addition to that, we think that map should show the 375 elevation, which is the one testified to by Mr. Bowman. Now from Mr. Bowman's testimony I understand that he was uncertain whether he had a map of the pool surface at 375, but they did have cross sections, and if it be true that they have no map of the pool surface at elevation 375, then we

think that they should produce certain cross section maps which Mr. Bowman said they had, showing elevation 375, at miles 30, 40, 50, 60, 70, 80, 90 and 100, or near thereto as might be available.

As to Exhibit 61, which deals with Pickwick Reservoir, we object, merely that again we think that the surface of the reservoir should be shown in color, or the outline should be made sufficiently clear so that it can be accurately followed on the map. There should also be added to 61 the scale of the map and the pool elevation at which the reservoir surface is shown on the map.

As to Exhibit 63, which deals with the Wheeler reservoir, we object again upon the ground that the reservoir should be shown in color, or else the outline of the reservoir made sufficiently legible that it can be traced accurately and readily.

Judge Allen: The entire set of exhibits is received in evidence and you may have your exception to the reception of exhibits 59, 60, 61 and 63.

Mr. R. T. Jackson: Your Honor, as I understand, if necessary, and it cannot be clarified by our friends on the other side, I have the privilege of asking Mr. Bowman about these maps. May I do that at this time?

Mr. Fly: I prefer not to do that, your Honor. I prefer to get on with this witness (Woodward) who is here testifying under a great strain. They are right in the midst of his cross-examination. I insist we proceed. I will stay after four o'clock to take care of the formal matters. The obvious purpose is a filibuster.

Mr. R. T. Jackson: I resent the statement.

Judge Allen: The Court rules you will continue the cross-examination of this witness (Woodward), and you may have opportunity to further examine Mr. Bowman later."

(The witness was excused.)

[fol. 1167] SHERMAN M. WOODWARD was called as a witness on behalf of the defendants and, having been first duly sworn, was examined and testified as follows:

Direct examination:

My address is Knoxville, Tennessee, and I am at present on the engineering staff of the Tennessee Valley Authority.

My title is Chief Water Control Planning Engineer. I graduated from the Engineering College of Washington University, St. Louis, in 1893. I later spent one year in the graduate college at Harvard. For the last 40 years I have been engaged in practical hydraulic engineering work, and in teaching different branches of hydraulic engineering. For eight years I was at the University of Arizona as Professor of Mathematics and Mechanics, from 1896 to 1904. From 1905 to 1908, I was employed by the United States Department of Agriculture as irrigation and drainage engineer. From 1908 to 1935, I was employed in the Engineering College of the University of Iowa with the title of Professor of Mechanics and Hydraulics. During all this time I was employed as a consulting engineer occasionally on different projects. From 1913 until 1920, I was consulting engineer with the Miami Conservancy District, whose offices are at Dayton, Ohio, which District constructed a flood control project costing about \$35,000,000. In 1921 and 1922, I was consulting engineer on a flood control project at Pueblo, Colorado. From about 1924 to 1928, I was consulting engineer for the Chicago Sanitary District. In 1934 and 1935, I was employed as consulting engineer with the Muskingum Water Conservancy District.

In 1933 I was appointed a member of a committee under the Public Works Administration in Washington which was called the Mississippi Valley Committee, and I attended [fol. 1168] meetings there during the next year, during which the committee reviewed many of the hydraulic applications that were presented to the PWA. That committee was continued after the end of the fiscal year under a somewhat different name and has been continued by executive order under different names, and is at present in existence and I am still a member of it. It is now called "Water Resources Committee of the National Resources Committee".

In the last 30 years I have served as consultant for a great many hydraulic projects where I was employed by cities, counties, state agencies, drainage districts and private engineers. I have worked on projects in Iowa, Illinois, Missouri, Arkansas, Mississippi, Colorado, Ohio and Kansas. About 1929 or 1930 I was employed as a consultant by the Bureau of Standards in the Department of Commerce in connection with the design of the National Hydraulic Laboratory which has since been built at the Bureau

of Standards in Washington: I am a member of various engineering societies,—The American Society of Mechanical Engineers, the American Society of Civil Engineers, Iowa Engineering Society, and various other ones of less importance. I am a registered professional engineer in the State of Iowa, which has reciprocal rules with about twenty states.

The only books that I have written have been either simple textbooks or obscure technical books that nobody else would learn about. I have written a few articles that have been published in various technical society proceedings, and I have written a good many governmental reports for the Department of Agriculture, for the Miami Conservancy District, and for the University of Arizona and various places, some of them so long ago I could scarcely remember them.

[fol. 1169] I began working with the TVA as a consultant in June, 1933, and worked intermittently for about two years, coming to Alabama and Tennessee occasionally. In the summer of 1935 I resigned my position at Iowa and accepted continuous employment with the TVA, and since that date have been with them with my present title of Chief Water Control Planning Engineer.

Cross-examination :

I entered TVA employment exclusively and resigned my other positions in 1935. I don't know whether it was June 1 or July 1 but it was in the summer of 1935.

Direct examination (continued):

That has not entirely excluded the consulting capacities which I have mentioned as continuing, such as membership on the Mississippi Valley Committee. I am still a member of this Water Resources Committee without getting any pay for it now, but I am appointed as a member of the TVA. On one occasion after my employment by the TVA, the PWA did want me to go into South Carolina and Georgia to make a special report on a project that took some time, and they employed me under the old contract as consultant, being paid by the day, and I took time off without pay from the TVA at the same time. But I have not done any consulting work to amount to anything since I have been with the TVA.

I am head of the Water Control Planning Department of the TVA. That Department was organized at the time of the general reorganization of the TVA as set forth in Defendants' Exhibit 41. That exhibit indicates that I am to prepare and issue instructions subject to review by the Chief Engineer, governing the impounding and release of waters at the various dams of the TVA to assure the maximum use of facilities and resources available for flood control, navigation and other purposes consistent with the requirements of the Act.

"Q. I note there the reference to the review by the Chief Engineer. Now I believe Mr. Jackson referred to that as being subject to the approval of the Chief Engineer. In issuing instructions for the control of the pool levels do you await the approval of the Chief Engineer?

Mr. R. T. Jackson: Just a moment. Are your instructions from the Chief Engineer in writing, Professor Woodward?

The Witness: I have never had any instructions in writing on this topic from the Chief Engineer.

Mr. R. T. Jackson: You have not?

The Witness: I think not. I don't recall any.

Mr. R. T. Jackson: Have you had any instructions at all?

Mr. Fly: I am asking what his practice is. You can cross examine him.

Mr. R. T. Jackson: I wanted to object to it as incompetent, because I assumed that the instructions would be in writing, and I think they would be the best evidence.

Judge Gore: He says they are not in writing.

Mr. R. T. Jackson: Yes. He didn't have any. It seems to me it would still be incompetent.

Mr. Fly: He has his instructions from the Board, according to this exhibit 41.

Judge Allen: The objection is overruled. The Court considers this witness is testifying, or will testify concerning the actual operations.

Mr. R. T. Jackson: May we have our exception?

Judge Allen: You may have your exception.

Mr. Fly: If your Honor will recall the authority delegated to Professor Woodward is clearly set forth in Defendants' Exhibit 41.

Judge Allen: The Court bears that exhibit in mind and the Court also has some conception of how businesses are managed."

In practice my instructions are not referred to the Chief [fol. 1170-a] Engineer for approval prior to issuance. My practice is to submit copies of instructions and keep him informed as to what instructions go out. So far as my knowledge goes, there is not at present any one occupying the position of Chief Engineer.

[fol. 1171] Examination by the Court:

So far as I know, the instructions issued by me which govern the operation of the water control have always been carried out. There is an Assistant Chief Engineer who has been there from the beginning, and who is the man to whom I report ordinarily in reporting to the Chief Engineer. There is still an Assistant Chief Engineer to whom I report as I always have. When I send it to the Chief Engineer, I have never sent it direct, but it always goes to the office of the Assistant Chief Engineer.

Direct examination continued:

Dr. Arthur E. Morgan was the Chief Engineer of the TVA until approximately early in this year, and Mr. Carl A. Bock was and still is the Assistant Chief Engineer. Mr. Bock had general control of the whole Engineering Department throughout that time. He is the man who is always there at the office and runs it, and Dr. Morgan was not there much of the time. Mr. Bock is the Acting Chief Engineer, that is, the acting head of the Engineering Departments.

I am head of the Water Control Planning Department and under me are several divisions which nominally report to me for all of their administrative purposes, a geological division, a division of maps and surveys, a division of engineering data, a project planning division of which Mr. Bowman is the head, and a division of general regional or Tennessee Valley area planning. I don't remember the name of it. We have lots of trouble in thinking up names to try to distinguish the different branches. I don't take any responsibility for social uplift. We have another regional division and I have to keep my own separate from [fol. 1172] that. I don't remember now just what the name is. All of these divisions report to me in a general way and I am supposed to keep track in a general way of all of it. This water control operation is not in any of those divisions, but was assigned to me more personally than the others,

and I have a small staff under me to carry out the work necessary in connection with that.

The engineering data division in general has charge of all of our measurements of water and related matters that are related to direct hydraulic measurements of streams. It does different kinds of work, including stream measurements, rainfall measurement, silt measurement. It operates a hydraulic laboratory at the town of Norris and it has a staff who make investigations and reports on all sorts of hydraulic questions throughout the whole Tennessee Valley area.

We are now getting reports from over 300 rainfall observation stations in the Valley, and some around the margins, just outside of the edge of the drainage area but close enough to be related. We received those reports monthly. About half of them are regular observers of the United States Weather Bureau, and we have a lot of our own, and we get them from private sources of all kinds. We try to get a report from every place that observes rainfall in the Valley. We also have a number of rainfall stations of the TVA itself. At all our dams and places where we have staffs we put in a rain gauging station and have someone on the staff make measurements for us. We continuously have the information furnished by those stations. We also have river gauging stations. We obtain the results of measurements of stations on the main river and the tributaries at about 150 points in the Valley. Most of those are operated in cooperation with the United States Geological Survey. Their staff does most of the work and we cooperate [fol. 1173] with them and furnish help. We get all of that information that is available anywhere. We get it from utility companies or from our own staff at times where we have engineers located. Whenever the results are issued in any printed form or any form available for distribution, we get all of those reports in the regular way. At times we get special reports by application at any time.

We also get a considerable number of daily reports on rainfall and river stages. We operate what we call the prediction service, which was initiated when our construction operation began on the rivers. That is for the assistance and protection of our construction operations, that is the way it started. Today we receive either by telephone

or telegraph reports on the rainfall and the stream stages from about 36 points, all of our construction jobs, and the others from the main, important points on the river. In addition, we have arrangements with about 30 other observing stations that when a heavy rainfall exceeds a certain amount, then they are to notify us by telephone or telegram, and also when there are sudden flood rises in the streams. In that way we keep in contact every day with all of the matters affecting flood flows in the streams. The degree of intermediate detail in our contacts will depend, in addition to that, somewhat upon the state of the weather and river conditions. We have issued instructions to all of these observers that if there are important sudden changes, then they notify us at once. We are also in contact with the other sources of information, United States Weather Bureau at Knoxville, Chattanooga and Cairo, whenever it is important we call them on the telephone for their latest information, and any place that we know to get it. We are interested in what happens at Cairo, because our operations on the Tennessee River at times depend upon the stages of the Ohio River, and the Weather Bureau observer at Cairo [fol. 1174] is the man who issues to the public the predictions below that are published in newspapers of flood heights along the lower Ohio River.

We issue a daily bulletin based upon the information we get from all of these various sources. We prepare during the forenoon of each day, except Sunday, a summary of the results of all these observations which is duplicated and issued about noon each day. This bulletin gives the names of all the important regions on the main Tennessee River. It gives the rainfall reported that morning, during the preceding 24 hours, the stage of the river and the amount of change from the preceding 24 hours, during the preceding 24 hour period; and in the reservoirs similarly the elevation of the reservoirs. Then we add to that predictions for the three following days; what we estimate the changes will be. That is duplicated and distributed about noon to about 150 persons.

When we are working on dams, or have other power houses, it is sent to them, to all of the important members of the staff, to all of the different branches of our organization that are interested, and to the United States Weather Bureau offices, United States Army Engineers, United

States Geological Survey, all of our cooperating agencies. That daily bulletin also indicates whether the river is rising or falling, or steady, and by these predictions what it will reach within the next 24 hours. We have at times issued additional special predictions to our own station. During the critical period last winter, we issued estimated changes up to five days in advance. The staff that makes up the bulletin estimates as they can, sometimes as far as ten days in advance. Of course that is only a guide, because we do not try to predict what the rainfall is going to be ahead, except we judge in a very general way from the United States Weather Bureau maps and the United States Weather Bureau predictions, but we know that our predictions in advance are limited by the uncertainties of the rainfalls. If there would be no more rainfall after we got the predictions any one day, we would know exactly, or very closely, what it is going to be for the next week. In our usual method of predicting three days in advance, we change each day as it is needed for the next day. That is issued for the guidance of our construction forces which are working in the bed of the river in many places, and it is a very important matter to them to know and be prepared for the changes in the rivers, especially during the flood season.

In making our decisions as to the impounding or release of the waters, we frequently need to act very quickly on important changes that have occurred. We make decisions all the time during the day as the necessity arises, and I have been called at night and on Sundays at times, in order to approve the proposed orders. We keep this force on duty night and day when it is in the dangerous part of the season, and on Sunday. Of course I am not there nearly all the time, but I have to approve any instructions that go out before they are issued. The general principles which control my operation of the reservoirs are set forth in the statute and the instructions in the resolution relating to reservoir operation.

“Q. Just to make it clear, Professor Woodward, then, in controlling the waters your effort is to control them primarily for navigation and flood control, is that right?”

Mr. R. T. Jackson: Just a moment.

A. That is correct.

Mr. R. T. Jackson: I object to that question. That leaves it for this witness to justify what he does, and why he does it. It is for the Court to determine that.

Judge Allen: The objection is overruled. In this bill bad faith is charged, conspiracy is charged. The witness may answer.

Mr. R. T. Jackson: An exception noted, please.

Q. What principles do you endeavor to follow in your every-day practical operation of all of these reservoirs, [fol. 1176] Professor Woodward?

Mr. R. T. Jackson: I object to that. He has already asked that question and the witness has answered it.

Judge Allen: He may answer.

Mr. R. T. Jackson: An exception, please."

We operate them for the benefit of navigation and for flood control. We have only two reservoirs in operation so far. It is but a small part of the complete projected system and the one that is under construction. There are four more dams under construction about half finished. We have not operated yet on the complete system and the operations that we have made, therefore, are limited and do not entirely represent the final complete system. We have found it necessary to vary our operations in detail in consideration of the construction project and what would happen to the construction projects at different parts of the river. We have had for the last two years these three dams under construction on the main Tennessee River. During the flood season, they are in a very dangerous position so far as financial losses go. Our operation has been very largely influenced by trying to control flood flows for their advantage. We have saved them, so far as I can tell, hundreds of thousands of dollars in preventing them from being flooded out at times. At times they have been in such dangerous condition that there might be possible loss of life if they should be flooded unexpectedly in the cofferdams when they are working down below these high flood levels, outside of their cofferdams. We have been very successful in giving them warning and in actually protecting them by regulating flood flows during the winter. Now, that, of course, is a temporary condition that will not exist after the dam construction is finished.

[fol. 1177] During the last two summer seasons we have operated the Norris reservoir for the benefit of navigation

in the lower part of the Tennessee River by regulating the minimum low flow. In the ordinary detailed operation, we base our releases from Norris on the gauge at Florence, Alabama. That is ordinarily used because that gauge is a very old gauge and has been used by all the navigation interests for a long time as a means of measuring the flow in the Tennessee River. During the summer of 1936 we attempted to operate the dam so as to prevent the water going below 15,000 C. F. S. on the Florence gauge. There was a little variation, but we were practically successful in maintaining that discharge at Norris throughout the whole of the summer season. During 1937 we have maintained it somewhere near 17,000 C. F. S. At times we have raised it above 17,000 C. F. S. for temporary navigation needs.

There have been various temporary navigation needs. There are two excursion steamboats which have made trips up to Alabama. One such steamer was the "Gordon C. Green" from Cincinnati, and the "Golden Eagle" from St. Louis. We attempted to regulate the flow of the river below so as to make it safe for their passage. The boat from Cincinnati is the largest boat and requires the greater depth. Usually when they get about half way up the lower river, they let us know they are there and we make special releases at Wilson Dam in time for them to get up to Wilson Dam and out again, so they will not be stranded. The boat from St. Louis has made frequent trips, and has made it a regular practice to let us know they enter the river and pass Pickwick site. We try to look out for them, and we have been entirely successful. So far as we know, they have not scraped bottom. They have pretty heavy passenger lists. One night one had to tie up on account of the fog and we lost it. We were quite worried, and could not find it.

[fol. 1178] That was not any lake but in the natural stream between Pickwick and Paducah. We have at other times made special releases for barges and for special boats. Whenever they apply to us if we can give them more water we do. In order to affect the Florence gauge by a release from Norris, it has to be made about four or five days ahead. So we have to predict approximately when they will need it at the Florence gauge and release a corresponding amount from Norris Dam.

Wilson is where the final release is made, but now it has to go through the Wheeler Dam and we release it. Ordinarily, Wilson could regulate it a little bit, but I don't think

it has been used for that purpose. We have been able to manipulate from Norris so that it has worked all right. When we release from Norris, we use the sluices. At that time of year all of the water is below the spillway and the sluice is the only way. That was in 1936 and it was also true during 1937, at any time during the low-water season in 1936 or 1937. In 1936 we released first on June 19, and the water had reached the level of only about 1,000, which was still 20 feet below the spillway when we started in 1936. This year it was at 1020 when we began the release. We have carried out that plan of release for navigation through each of the low-water seasons, the only two we have had since Norris Dam has been in operation.

In my opinion it is feasible to draw down the main stream dams in advance of floods to increase their effectiveness for flood control.

By Mr. Fly:

"Q. Will you state how, in your opinion, Professor Woodward, the dams on the main stream of the Tennessee may be operated for the most effective control of flood waters at Cairo?

Mr. R. T. Jackson: I object to that question, because it is not limited to practice.

[fol. 1179] Judge Allen: The witness may answer. It calls for his opinion as to the practicability of operation.

Mr. R. T. Jackson: Our objection is limited to the materiality.

Judge Allen: One of the issues in the case raised very strongly by the complainants. He may answer and you may have your exception.

The Witness: Well, the plan which we have in mind for operating them, in my opinion, is the plan which will be most effective. Shall I describe the plan that I have in mind for these operations?

Mr. R. T. Jackson: I object. I think the witness should limit the testimony to his opinion about it and not undertake to say he is stating a plan of the TVA.

Mr. Fly: Your Honor, Mr. Jackson has chosen to try the case of operations without anything to operate. Here is a man charged with the plan of operation by the Board of Directors of the Tennessee Valley Authority. He can go into these operations, by looking into the future. If Mr.

Jackson wants to hear proof as to operations here is the man to use.

Judge Allen: This witness may testify as to the practicability of operations, what he considers practical of operations on the dams constructed and under construction.

Mr. R. T. Jackson: Our objection now, does not go to his opinion at all. It is just a question of his trying to state the TVA plan."

Examination by the Court:

In my opinion the practicable plan is to hold these main river reservoirs near their minimum level throughout the flood season and on the approach of floods to draw them as low as possible, which may be a little lower than they have been held before. Then when the floods come to close the gates so as to hold back as much water as may be held at each dam. It is impossible to say in advance of the actual case just when that storage should be made. It should depend upon the size of the flood and the apparent prospective length of the flood. We do not intend to have any rigid [fol. 1180] rule for the control of the discharge time. It will depend in every case upon the conditions, and due to climatic conditions. This is the general principle on which we operate the dams that are in operation. Wheeler Dam is the only one on the river so far in that condition.

Direct examination continued:

We have operated Wheeler in just that way. Last winter we operated in that way and are starting to operate that way this year.

With respect to the significance of the location of the main stream dams as regards Cairo and the probable prediction of the flood, Gilbertsville Dam is of course very close to Cairo, about one day away in time. The other dams are not so close, but I think that even up to Chattanooga will be within what is called prediction distance of Cairo, in which they can predict an Ohio flood to reach Cairo. It is also true that having a series of dams, they can be correlated, and if they could not operate a dam near Chattanooga with 100 per cent accuracy, the lower dams will help us to smooth out any variations from proper operation, because they are close and can store the excess of water that might possibly be passed through these dams. If we want to release more

we can release more. They tend to help each other in operation. In speaking of dams up to Chattanooga, I mean to include Chickamauga, and that will be true in a lesser degree even in the higher dams. I think Watts Bar and Coulter Shoals can be operated in conjunction with the others. We expect to learn by experience from this operation, and I am confident that we can do a pretty good job from the start. I don't say anything about the low water part of the year.

[fol. 1181] There is not any distinct line between the low water season and the flood season, one turns into the other over a couple of months, and is different every year. But I think it is practicable that as we approach the spring, and the danger of the biggest flood passes, we can then store water. The pool is then below low water and not as high as the flood water that comes in the spring with the rains. With that flood water we can bring the main river dams up to their maximum level that we would use for flood control during the winter. Then that water that is stored can be released during the low water season to help out the low water flow. It can also be used for malarial control, which is a serious problem in the Tennessee Valley. In actual operation we distinguish in the detailed method of accomplishing our purpose between the tributary stream reservoirs and the main stream reservoirs. We view them quite differently, because the scale of operations is so different. That different system of operation would not be applied to Norris or Hiwassee or Fontana, or any dam that would be built up on the tributaries.

With respect to the method by which we are actually operating the Norris Dam, we draw it down during the summer and about this time in the year leave it down near the minimum level, which will be probably around 960. It will vary somewhat in the different years, and it may vary some from experience. As the winter or flood season comes on, we will hold it low, but not at that minimum level all the time. As the flood season nears its end, we will permit it to be filled partly, and starting April 1st as about the end of the worst flood season, we expect to have it partially filled up on April 1st. After that date, it will be our practice, during April and May and possibly the first part of June, if there is water enough, we will fill up to the spillway level of 1020. [fol. 1182] That is about the normal ideal operation. Every time a flood flow comes along, we will store that flood in

Norris and it will be filled up much higher than the amount I have spoken of, and after the flood has passed we will let it out to whatever stage we think necessary to have it in the winter and spring.

Examination by the Court:

If there was a flood in May, we would control that also. Suppose it is at 1,000 or 1010 the first of May when this flood would come along, we would not be worried at all with the pool filled up to 1020. If we needed more space to store, then we would raise the gates up and store whatever we wanted to. Of course, if we would have an excessive amount of flood water we would release it when we thought it was safe. It is a harder problem to release flood water than to store it. We might release it at once, in a week, two or three weeks, gradually, depending on the condition down the river, and on the Ohio and Mississippi.

Direct examination continued:

If we have water enough in the latter part of the winter season, we fill the Norris reservoir up to 1020 and hold the water until it is necessary to release for the low water control. Whenever that is necessary, we release all summer. In some summers we would not need as much as others. For example, this last summer was not a dry summer at all and we did not need to release from Norris in any amount as is generally expected for the low water season. So we have let it out, but not to give low water regulation. The reservoir would be at 1020 in the later winter months, about May and the first half of June. That is, we would bring it up to a certain level, say 1,000 or 1010 at the end of the flood season. [fol. 1183] Then we would hope to catch enough to bring it up to about 1020 before the low-water season starts in. It may be once in every five to ten years that the reservoir would not get to 1020 for the summer.

The same principle of operation would apply to other tributary dams such as Hiwassee. Hiwassee will not be operating for a couple of years, and not being very immediate we have not worried about that. It is not so big as Norris either. We do not follow any precise arbitrary rule in filling the Norris reservoir, I do not think we can have any fixed, precise line. There will probably be a variation of at least ten feet in different years of the level on the same dates in the winter.

Examination by the Court:

As to how low we can draw the pool in Norris Dam without affecting generation of firm power, I would state that unless you are having a fixed amount of firm power, there would not be any very definite volume. That is my opinion. I am not a power expert. I have never worked in my life on a power project. I have, of course, made elementary estimates of various kinds, but I have never made any estimate by which I can answer that question.

Direct examination continued:

No firm power is being produced at Norris Dam, considered at the dam itself, because the power plant is not running very much of the time, and we do not contemplate running it much of the time. It would be possible, if it was a separate isolated plant being run by a private utility, to change its operation so as to produce firm power. There must be a discharge of water in order to obtain firm power at Norris Dam. There will be and there are substantial periods at which no discharges are made at Norris Dam. [fol. 1184] In the past the part of the time that these discharges are entirely shut off from Norris Dam is extremely irregular. Perhaps a quarter of the year, sometime in the spring and some in the fall, and there might be times during the winter—there will be whenever flood control is being exercised. It will run into a matter of several months all told.

There are reasons why you should have for flood purposes more empty storage space at the beginning of the flood season than at the end. The demands on the reservoir for storage will often be very much greater at the beginning of winter than there can be at the end of the flood season. We have in this region some years, long continuous wet periods. I think this will be the greatest test on our flood control system. We also have sometimes some very short extreme storms of the kind Mr. Kurtz used in his testimony. I think it will probably be a more severe test in this region to take care of the long, extreme wet periods of which we have had some examples in the past, and that will be especially necessary for the protection of Chattanooga and the assistance of the Ohio and Mississippi. You are apt to have a repetition of floods

in the early part of the flood season and continually need to store water. It is a repetition of rainfall and the floods do not come separately but continuous, with the rainfall coming every day, every few days, or every week. That has happened many times. Under our plan of actual operation, we expect to have still enough remaining storage space at the end of the flood season to take care of floods that could be expected as within the range of probability at that season. At the end of March, which so far as all past records go is at the end of the very extreme peak of flood peaks, we will still have enough to take care of any expected floods. If a flood came along in May, we would control it the same as the other. We do not expect any very extreme flood in May, but there may be small floods, as there may be throughout the whole summer. We have relatively small floods all summer. At any time in the year they may come. Under our plan of operation we will have enough space available in May to take care of any flood that we may contemplate at that time.

We have reliable detailed records for about 35 years, and we have less accurate records of the past floods before that for another 35-year period. We have flood records for about 75 years in all which we can use. Our big floods come in the winter. We may have a moderate flood in November, a little more frequently in December, still more frequently in January, then they may come at any time during the winter up to the end of March. We have never had any big flood in the Tennessee that did not start in March. They have persisted in April, but the floods which have arisen in April have been distinctly smaller than the previous months. I think the main flood season is the first of January to the first of March, and the boundaries are not very precise. In the summer it is relatively a flood-free season. We do have small floods in the summer, so that the rivers get out of banks, destroy crops, but not very much. They are not serious though so far as cities and railroads are concerned. The high temperature and growing vegetation in the summer make the ground dry, and a large amount of the rainfall is soaked up by the vegetation and the dry ground and does not go into the stream. The same kind of rainfall which increases the stream flow in the winter makes no appreciable difference in the stream-

flow in the summer. I should have said the major flood season could be assumed to close, roughly, the first of April or the last of March.

[fol. 1186] Having a greater amount of space available in the early part of the winter affects our ability to alleviate floods on the Mississippi. If we have a sufficient space at the beginning of the winter, we can store the water for a long time so as to cover flood conditions on the Mississippi such as existed last winter. Last winter we stored all of the flow in the Norris Reservoir for about six weeks, beginning in the latter part of December and extending until the first of February, and that period was extended so as to keep what we could out of the Ohio and Mississippi Rivers. During that specific time we did block the entire flow of the Clinch River at the point of the dam. The Mississippi flood season is longer in the spring than that of the Tennessee, because it takes a long while for the flood waters from the upper end of the Ohio river and the upper Mississippi and the Missouri to reach down into the lower Mississippi valley. It takes four weeks, I suppose, at least for waters to go from Pittsburgh down to New Orleans or perhaps Memphis. So the flood season is much prolonged down the lower river, because of that longer period of time for flowing down the river. Sometimes we have local floods in the Tennessee Valley that affect only a single tributary, or perhaps one or two tributaries. However, in general the whole valley is covered by floods at the same time, because our winter rains are very widespread and quite uniform over large areas. The summer floods are very erratic. We can have a flood on one stream and not have other streams have any flood.

In my opinion the value and effectiveness of the Norris and Hiwassee storage reservoirs for flood control on the Tennessee River and Mississippi River will not be materially diminished by the method of operation I have described. I think this is the best way to operate them for flood control, the way I have described. For attaining Tennessee and Mississippi flood control only, without reference [fol. 1187] to other uses, it would not be necessary to fill these reservoirs partly. The partial filling is not for flood control, but is for the benefit of low-water regulation. If I include that, then I know of no other way to operate them.

"Q. Does the principle of seasonal filling have any benefit on the Mississippi, that is effectually on the Mississippi, as distinguishable from the Tennessee?"

Mr. R. T. Jackson: I would like to say that if this witness intends to express any opinion on navigation I want to object to the question on the ground of competency of the witness.

Judge Allen: Do you object to the competency of this witness as to navigation, Mr. Jackson?

Mr. Jackson: Yes, your Honor.

Judge Martin: He may answer.

Mr. Jackson: May we have our exception, if your Honor please?

Judge Allen: He may answer. The Court bears in mind that under the definition of duties of this witness by the Tennessee Valley Authority, he is to prepare and issue instructions regarding maintaining and releasing water to insure the maximum benefit for flood control, navigation and other purposes, consistent with the requirements of the Act.

Mr. R. T. Jackson: If your Honor please, I want to state our position only, and not argue it. It is my understanding that the accolade of an expert in any field cannot be bestowed by statute. If it could, I would seek one. I think that does not aid the qualifications of this witness in that field, and my objection is to the lack of any showing of qualifications in that respect. My recollection is that the same resolution refers to power, but the witness has disavowed any qualifications on that subject.

Mr. Fly: It just happens that resolution didn't relate to power.

Judge Allen: The witness has testified rather in detail concerning the impounding of water, concerning aid to navigation. That was under your direct orders.

The Witness: It is, yes.

[fol. 1188] Judge Allen: How long have you been doing this specific work for the Authority?

The Witness: Why, this present organization set-up dates from about July 1st, last July. During the preceding year my advice was used all the time. I suppose I directed it more than any other person during the summer of 1936. The release was started at my calling attention to the fact that it was necessary.

Mr. R. T. Jackson: May I correct the record by pointing out that exhibit 41 does not, as Mr. Fly says, omit electric power, but the very end of sub-section B. describing the duties, says that 'Define from day to day the extent to which water may be impounded in the stream flow, the limits within which the impounded water may be used for the generation of electric power.' But the witness has disavowed the conferring of expert qualifications by statute, and I have no objection to his stating anything about hydraulics, that he increased the flow or changed the depth or something of that character, but as to the navigation I think he is not competent.

Judge Allen: He may answer.

Mr. R. T. Jackson: May we have our exception, please to the Court's ruling."

The seasonal filling up which I have described has effectiveness for flood control on the Mississippi as distinguished from the Tennessee. It operates in this way, that the difficult part about operating reservoirs is getting rid of the water after you have got it in there, and it will be necessary at times to hold it for a long time for the benefit of the Mississippi, when we could let it out if we were concerned only with the Tennessee River without reference to the Mississippi. So by having this great amount of storage and being able to store all through the winter, we will be able to take care of successive floods, even if we do not get rid of all the water from the earlier floods. That, of course, gradually fills up our reservoir until we can get rid of the water.

[fol. 1189] We do not maintain Norris at elevation 1020 for a very large part of the year, perhaps a month or so, probably less than that on the average. It might be that some years. Some years it might not be maintained there at all the whole year.

Cross-examination:

I do not mean the average of the two years since it has been operated. I am thinking now of how the reservoir would have been operated during past years. I can tell about what it has been during the last two years. In 1936 it never was at 1020 at any time, but in 1937 it was for two or three weeks, I think, in the spring, at 1020.

Direct examination continued:

"Q. Now what is the so-called normal pool elevation on the main stream dams? Can you state in general what that is, and then state what your operation is in regard to that.

Mr. Fly: I will limit that question to the dams already in operation.

Mr. R. T. Jackson: For the record we would like to note the objection to this question as we did yesterday because those elevations are fixed and determined by the Board and not by subordinate officers.

Mr. Fly: I want to go right into that question.

Q. Professor Woodward, who fixes the day to day, month to month levels on these reservoirs, who is charged with that duty?

Mr. R. T. Jackson: The same objection.

A. I am.

Judge Allen: The objection overruled.

Mr. Jackson: On the ground of competency of the witness.

Judge Allen: You may have your exception.

Mr. R. T. Jackson: Competency of the witness to prove his own authority.

[fol. 1190] Mr. Fly: The resolution established that.

Judge Allen: The objection to the question is overruled. The Court considers the actual practice of operation of these dams is competent to be shown in this case. And you may have your exception.

Mr. R. T. Jackson: I note an exception.

Judge Allen: It may be explained by the men who are in charge of it, that is the ruling of the Court. You may have your exception to that.

Mr. R. T. Jackson: That is not my objection, if the Court please."

To me, the normal pool elevation on the main stream dams has never meant anything definite. It is a sort of average between the highest level and the lowest level at any season, so far as I know. I have never used that normal pool level in my own work. I have been asked many times by people at what level are these dams going to operate, or, what is the normal pool level. They usually do not want any extended

explanation as to the variations, that way, so far as I know, but a kind of average. And if I use it, it is to give them what they want, a general average. Now, regarding the actual operation we pay no attention to it whatever. The reservoirs are fluctuating all the time, nearly every one, one way or another, and it is the limits of those fluctuations that we deal with. We don't endeavor to fix the level at the so-called normal pool level because it is so-called.

During the summer the main stream reservoirs are fluctuated for malaria control. The general plan now recommended by our health service,—and I am not an expert in the health line, I take that entirely from the doctors that we have and the Sanitary Engineers associated with them. They would like for us to start with the reservoir as full as possible in the spring, because vegetation does not start [fol. 1191] growing under the water line, but does start growing very freely just above the water line. They think it is very important to keep that growing vegetation down to a minimum. The reason for that is that the mosquitoes grow in the water along the edge of the vegetation very rapidly. Then they ask us to vary the water level in about a week or ten days, because that seems to sweep out the larvae and very much reduce the number of mosquitoes. To do that, when we can, we drop about a foot, and in the course of a couple of days, it may be that it will stay at the lower level one day, then we bring it back in two or three days to a higher level. We do not try to bring it back to the level it had before, but a little less. Say if we drop one foot, we raise about ten or eleven inches. The next time we drop, we drop a foot and in a few days when it comes back it comes back again ten or eleven inches. In that process the reservoir is going down throughout the summer, also fluctuating as much as we can.—That is the present approved plan that we have recommended by our health service.

We have tried at various times to make changes in the plan, but so far as our experience and the experience from other places is concerned, that is the approved plan. This is all in a process of experimentation and development, and we do not know what better details can be found out. Under that system the reservoir is slowly dropping throughout the summer, fluctuating all the time. It is also true that we get these summer floods which may raise the reservoir a foot or two without our planning deliberately to do so. Then we start over on the fluctuation, if it is raised up two or three

feet nearer the top or high level, then we start down on the same plan. That persists throughout the summer, as long as the mosquito season lasts. In winter it is different. As soon as the flood season comes on, we hold up the bottom [fol. 1192] level until the increase in the stream flow requires us to raise it. By bottom level I mean about the minimum navigation level. We try to hold it there throughout the flood season. That is the way we have endeavored to actually operate the dam during the last year. The so-called normal pool level then is the average between the water heights in the low-water season and in the high-water season. I have never fixed a normal pool level myself that I remember of. It is just something that is put on a drawing to make a picture of. The dam is not physically divided off in any way so as to distinguish these different levels for the purpose of operation. I can not think of anything that marks it on the dam.

Examination by the Court:

The time when we fix the levels in the normal routine of our office varies a great deal. We issue our instructions in a written form, and I suppose they average about once a week. At times in the year when there are no problems to be met, it might not be changed for several weeks. We have issued them on almost successive days once or twice where some change had arisen, so we had to change our instructions. We put everything in writing for the purpose of the record, because we have stations over several hundred miles of river. Although we do a great deal by telephone, we always confirm by the permanent record.

Direct examination continued:

I mean in distant stations we transmit the emergency problems by telephone. We read it over the telephone, they take it down in writing, and we tell them they will have our printed copy the next day.

[fol. 1193] Cross-examination:

Referring to Defendants' Exhibit 41, which is a resolution in which it is asserted that I am acting as Chief Water Control Planning Engineer responsible to the Chief Engi-

neer, that is not the date when that department and that duty were created. The department had existed for two years before that. It is true that the resolution says that there is hereby created a Water Control Planning Department. As to whether the resolution speaks the truth as to when the department was created, that perhaps applies to a legal interpretation of the thing. What had happened was, when I went on permanent duty, the Engineering and Construction Department, as it used to be called, set up an organization with my department in it. It was less formal than this, and so far as I know it was never approved by the Board. I think that this last summer, at least so far as I know, was the first time that we ever had as formal an organization as this. We had a general manager appointed in June, and this organization was in connection with the general manager being appointed, and this formal organization I think is extended all throughout the TVA. So far as I know the Board never formally set up my department. Of course the Board approved my appointment and my title some time before July 21, 1937, and my salary. I certainly do not think that the setting up of this department had anything to do with the pendency of this litigation. So far as I know, it didn't.

I have in my department a number of rain gauging stations and river flow gauging stations. These rain gauging stations have largely been maintained by the Weather Bureau for a number of years—about half of them have. The great volume of the Weather Bureau rain gauging records are not published in the papers at all. They are only sent in once a month. So far as the great bulk is concerned, they are published some time after the end of the month, and annual summaries. There are Weather Bureau stations that have annual employees in the big cities, some 60, perhaps, in the whole country,—one at Chattanooga. They are published daily in the daily papers, but many times, I think about 4000 of them over the whole country, generally in the little towns, do what is called the cooperative observations, and they are sent in monthly. That is gathered in the monthly and annual reports. Persons desiring that information can get it from the other cities.

The United States Geological Survey service is a distinguished and old organization of the Government which prepares and has prepared for many years reports on the

rivers and weather conditions. I think it is a fair statement to say that its records and its stations have been the principal source of information for hydraulic engineers, public and private, for many years. They are still engaged in business, since the formation of the TVA, and they publish their readings and records, and publish papers entitled "Water Supply Papers". These water supply papers cover all, or at least all the principal watersheds in the country and go back for a long period of years. They are very chary of publishing other people's records than their own in magazines. They refuse to publish other people's records because they say they can not guarantee the accuracy. In some cases though they do accept them and publish them. I think they publish all that the TVA furnishes. In some cases they have gone back to the Weather Bureau records which antedate their own records to supplement their records for what they are worth.

In my operations I have been protecting these TVA construction crews in the river. Some private companies have built dams and structures in the rivers for many years. I [fol. 1195] think those companies have utilized the records of the United States Geological Surveys and Weather Bureau with fairly good success in preserving their own lives and their own property.

I do not think that our predictions of gauge heights are used by navigators on the Tennessee River. I do not know how much they use predictions of the Weather Bureau or of the United States Geological Survey, as it does not issue any predictions anywhere that I know of. I have never been in the navigation business, and I don't know whether or not it is a fact that on all inland water navigation in the United States the navigators base their operations upon predictions issued by the Government Bureaus and have done so for many years. I do not see why they should not utilize them as far as they can. I would think that they would utilize the Weather Bureau predictions if they could. Where there are locks on the river, as the Ohio River System, for example, every lock tender gets information more than once a day on the stages at the locks, both above and below, from the Army Engineers under whom those lock tenders work. I know that the vessels in traveling up and down the stream do get the information from the lock tenders as they come through the locks. I think that is most useful information. The fact is that that is part of the service of the Corps of

Engineers of the United States Army on inland waterways. I hesitate to state that this is based on the Weather Bureau information, but in many places the United States Army Engineers and Weather Bureau operate different services on these predictions and they don't agree. In some cities there are issued to the newspapers, if they ask for it, two sets of predictions, which is very confusing to the public. I think they are trying to get together. The introduction of a third one would be just too bad. If we extend our operations into that territory, we would certainly try to co-operate with them and agree, and have it under one service only.

[fol. 1196] I told about these predictions that we make and said in illustration of our practice that we released water during the low season of 1936 and 1937, in order to increase the depths of the river downstream. I think the draft of the steamer from Cincinnati—the "Gordon Green"—was at least five feet and not over six. The draft of the "Golden Eagle" from St. Louis was about a foot or a foot and a half less, as I recall. I think the maximum draft of the two steamers was about six feet. It might be a foot difference. They were plying from Paducah to Florence and did not go beyond. Then they turned back. If we had had these low navigation dams from Paducah to Florence, they would have had ten or twelve feet all the way, but that would not have been quite twice as much as they needed, because they would like to have at least 1 foot more than their draft. It is true, however, that they would have had a great deal more water than they needed. I don't know how long it would have taken to have built those low dams from Paducah to Florence if they had gone at it in 1932 or even 1933. It took about 30 years, as I recollect, to complete the Ohio river dams. I don't know that they ever got them all completed at one time, but they began renewing them before they were finished, I believe. It is not my testimony that it would take 30 years to build one of those navigation dams on the Ohio River. That was the actual time during which they were built. That is, they authorized the plan and they were 30 years in putting up the money and actually carrying it out. I think it depended on the money. If any one had come along with the generosity which the TVA discovered in 1933, in my opinion, although I don't qualify as an expert in that field, I think that those low navigation dams from Paducah to Florence could have been built in three or four

years. If they had been built, the "Gordon Green" and the "Golden Eagle" would have plied that river with the con-[fol. 1197] sciousness of very large factors of safety before this time. They would not have needed our releases.

I spoke something about releasing a little water for a barge, or barges. I do not remember that I ever knew how much water they drew. I don't think they come from the 9-foot channel in the Ohio and upper Mississippi Rivers. I think they were engaged in local transportation on the Tennessee. Some of them may have been hauling material for the TVA. Probably all of them were not, as we have some barges handling ties and sand and gravel for other people, occasionally. They have asked us for help sometimes. It has not been very frequently or very important. I don't always even know about these cases and I don't follow it that closely. I think the sand and gravel movement is mostly local, but it is at all of the cities. It has been going on long before the TVA was proposed.

When we released this water to enrich the flow in 1936, I think it increased the power down at Wilson. In 1937 I doubt whether it did. So far as I remember, they were not operating to capacity in 1937 down at Wilson; and as I said, this last summer was a rather wet summer and there was not much need of low water relief. I do not mean to testify that the low water flow in 1937 was sufficient to operate the installed generating machinery at Wilson Dam at capacity, but so far as I know it was never operated to capacity in the summer of 1937. I do not really know whether the reason for that was because we had not yet been able to sell enough power.

I also stated that when we let this water out, to float the two steamers, we let it out by sluices at Norris Dam. Whenever we are releasing water from Norris Dam, it had to go through the sluices. As to why we did not run the water through the generating machinery, that was not a matter of [fol. 1198] principle. The actual operation of the gates at Norris Dam is done by the staff of the power house. They are not directly under my jurisdiction. It would be too bad if I find they release a lot of water for power that I don't know anything about, as they are not under my jurisdiction, and it would upset all of my other instructions. The power house stations are under an officer who is, I believe, called Superintendent of Power Plant Operation—Mr. Karr. We give our instructions to Mr. Karr. But often we at the same

time telephone them to the power house operatives for their information, but they report to him and carry out his orders. We assume that he transmits our orders to them. The reason why we communicate with Mr. Karr in charge of the power division if we are simply wanting to discharge water through the sluiceways, which has nothing to do with power, is that we have only one staff over there to operate the gates and operate the power house,—the same men. We could not have them operating under two bosses, we think. We might get into trouble. We do not care which way the water is released, whether it goes through the sluices or turbines. We do not even know whether they want to operate those turbines or not. We tell them just how much water to release. It is entirely immaterial to me whether this great power resource runs wasting to the sea through the sluiceways or passes through the generating machinery.

It appears at page 462 of Complainants' Exhibit 116, the Second Deficiency Appropriation Bill for 1937, that in eight months Norris hydro-electric plant generated 91,971,000 kilowatt hours. That was, of course, not run through the sluiceways. That went through the water wheels.

I don't know enough about the firm power capacity down at Wilson to know whether the water discharged from Norris, regardless of how it was discharged, was increasing it [fol. 1199] or not. I do not know what the firm capacity at Wilson is. I was to a certain extent in charge of the flow down at Wilson. I do know, as a hydraulic engineer, that the increase in available flow through generating machinery, so long as it does not exceed the capacity of the generating machinery, would increase the firm power capacity, unless at some other time or point it is restricted. I am inclined to think that this release in the summer of 1936 did increase the firm capacity at Wilson Dam.

We started to fill Norris Dam on the 4th of March, 1936. It is not quite accurate to say that March 4, 1936 was the first time any water was ever impounded in Norris Dam. The water level was raised there about 40 or 50 feet during a considerable part of the construction period. It was a very small pool above. Substantially, so far as maintaining stream flow is concerned, it is true that March 4, 1936 was the first time the dam was put to use. We did not get it full that spring. We stored all of the water, I think, until June 19th, and it was not full. I guess one reason we did

not get it full when we stored all of the water was because we started so late. I have not made the calculation to ascertain whether if Norris Dam had been ready for operation throughout the winter of 1935 and 1936 and we had kept it as low as we had it down to March 4th, we would never have been able to fill the reservoir for low water navigation. It is not correct to state that I do not have to calculate that because we tried it out and found out we could not fill it after March 4th, because it started much lower than it would have been—that is, about 860. We cannot lower it much below that. When we have the sluices all open, it stood around 860, as I remember. There would have been about 400,000 acre feet of water in the reservoir, from there up to 955 perhaps. There is only about 500,000 acre feet up to 955, altogether.

[fol. 1200] I said that we released this water during the summer. I think ordinarily one would release stored water during the low water season if they were in the power business and had a plant down stream. We released this water, however, without generating power in 1936 at Norris. The first power unit was ready for operation in the latter part of August, 1936, so that unit, I think, was producing power. I think it was the second unit which was not ready for operation until about November 1st. I think that that generator was running fairly steadily for two or three months in 1936.

I am sure I do not know whether or not at the end of 1936 we had a contract with the Aluminum Company of America in operation for supplying power. I never have read any of those contracts. They are published in the Annual Report, but I have never read them. In my jurisdiction over the operation of Norris Dam and the reservoir and the use of its water, it was not my impression that it was being used to generate a large amount of power for the Aluminum Company of America at the end of 1936. I thought we were selling it to the Alabama Power Company. I don't remember who told me that. That was just current newspaper rumor.

I have heard of the Aluminum Company of America in the course of my official duties with TVA since I have been living down here, and have visited their plants many times. I knew they were building a transmission line to take power from Norris Dam quite a long time, but I do not know whether it was finished at that time. My impression is that we did not have any connection with them until after that.

I do not know whether it is a fact we started delivering power from Norris to the Aluminum Company of America on December 11, 1936. I do not know anything about whether we were making such deliveries in December, 1937. The increased releases at Norris Dam in December, 1937, [fol. 1201] were not, as far as I know, in any way affected by the delivery of 50,000 kilowatts of energy to the Aluminum Company of America. I did not know that. There has been an increase in discharge from Norris Dam since December 11, 1937. We also discharged a large amount back a month ago, but I can't remember just what date. If there is a large increase in discharge about December 11th and if we started delivering from Norris Dam to the Aluminum Company of America an additional 50,000 kilowatts of power at that time, that coincidence is purely accidental, if it happened. We are discharging at the present time 15,000 cubic feet a second at Norris Dam. The maximum amount that can go through our water wheels, when the water is at the top of the dam, is about 9,000 cubic feet per second. That amount decreases as the head goes down because only so much will enter the wheels. At the present stages, I suppose perhaps 8,000 could go through the water wheel, if both of them were running to full capacity. As a matter of fact we are discharging 15,000 cubic feet per second there. So whether the water wheels are running or not, I don't think it makes any difference. I did not know the Aluminum Company of America had their 50,000 kilowatts. I say it is an accidental flow so far as power is concerned.

The reason why we are discharging 15,000 cubic feet per second is that we are trying to draw the reservoir down to its winter level. We would have had it drawn down before this, but we have had various interruptions. There were a lot of tests made on the water wheels, to satisfy the purchase specification requirements, and this took several weeks. We also held back the stream flow at one time for the benefit of our construction forces at Gunter'sville Dam, where they had driven their cofferdam clear across the river. And when they were just finishing that construction, they were in a rather precarious position, so for a week or two weeks we pretty nearly stopped all of the flow at Norris Dam. Now, [fol. 1202] we have the way all open and are lowering the reservoir about a foot and a quarter each day in order to get down to our winter level.

I stated that when we started to fill Norris Dam about March 4, 1936, we started, I suppose, with about 860, but I don't remember definitely. That is where the water stood a long time before that. Referring to Defendants' Exhibit 50 offered by Mr. Bowman, which shows that the storage in acre-feet at 900 is 108,000 acre feet, this would be lower than that. I said it might be 100,000, but probably it was somewhat less. I was just guessing that from being familiar with that curve, but I did not have anything before me.

It is not a fact that the water wheels installed at Norris are designed so that they operate at their maximum efficiency when the pool is at elevation 1020. I think the maximum efficiency is when it is about 1,000, but I am not sure. There is a maximum point in there, or a point where the efficiency is a maximum, which is not the highest nor the lowest. When you get away from that point, either water too high or too low, the efficiency is less. It is fairly uniform for quite a long range in the center, and the further you get from that point the less the efficiency is. I do not know how rapidly the efficiency begins to decrease as you drop down towards 955. It does decrease some. I am not an expert in the design or specifications for water wheels.

When you ask whether the third largest flood of record on the Tennessee River reached its peak in April, I think you are probably referring to the flood of 1886. The peak of that flood was in April. I don't remember whether the largest and second largest floods of record occurred after the middle of March. The flood of 1886 started in March, about the last three days of March, and the storm started then and the peak came a week later probably. It is also true that the maximum flood at one point in the river is not [fol. 1203] perhaps the same as the maximum flood at another point in the river. These floods are sometimes more in the upper end of the river system, and sometimes the lower. Speaking of the peaks of the second largest flood or the third largest flood will not definitely locate the flow. I would never use the language, however, that it might be a big flood in the upper end of the river and the valley storage has ironed it out into a small flood at the time it gets to the lower end.

By Mr. R. T. Jackson:

"Q. Mr. Woodward, I would like to invite your attention to a statement on page 132 of the Hearings before the Sub-

Committee of the Committee on Agriculture and Forestry, United States Senate, 71st Congress, First Session, dealing with conservation authority, and being from a document inserted under the heading of Tennessee Valley Authority Water Control operations, January 1937 Floods, and particularly this paragraph:

‘Water Control Operations • • •’

Mr. Fly: I object to going into a hearing on the Conservation Authority’s bill.

Mr. R. T. Jackson: It is a resolution of the Board of Directors dealing with Professor Woodward.

Mr. Fly: I object to going into those hearings.

Judge Allen: Is this one of the hearings that is in evidence?

Mr. R. T. Jackson: No, it is not, your Honor.

Judge Allen: Would you mind showing that to us?

Mr. R. T. Jackson: This is as I have stated, a resolution by the Board of Directors, the particular paragraph I want to ask Mr. Woodward about is this one, which is one with reference to his office or department at that time. My purpose, I might say, is to use it to refresh his recollection as to the organization of his department.

Judge Allen: The objection is sustained.

Mr. R. T. Jackson: And may we have our exception?

Judge Allen: Yes.

Mr. R. T. Jackson: And in order to complete the record, may I ask the Reporter to copy in as a part of my question, first the material under the heading ‘Water Control Operations’ at top of page 132, and then show that I ask Professor [fol. 1204] Woodward whether that refreshes his recollection as to the Authority under which his department was operating at that time; and then let the record show the objection, the ruling of the Court and the granting of the exception.

Mr. Fly: I do not think your Honor, that such a way ought to be adopted for getting all of that statement into the record, through the question and therefore into the record of admitted evidence. I think it ought to go just as all others do into the excluded part.

Judge Allen: The Court has ruled that the evidence is rejected.

Mr. R. T. Jackson: I was only trying to save time, as I understand I have the right to put my question, read it and

then have the ruling of the Court on it. I was asking whether that might be copied and the delay avoided. If that is agreeable I will deliver this to the reporter.

Mr. Fly: That goes into the excluded portion, as the Court orders."

(Said excerpt from the TVA Board resolution is as follows:)

"Water-Control Operations

The Board of Directors on June 30, 1936, adopted bulletin No. 1 and approved Bulletin No. 2, as recommended by the Hydro-electric Committee, and established the following procedure with reference to the preparation of subsequent bulletins and the administration of the requirements of these bulletins.

1. A committee on Water-Control operations is created consisting of the Chief Water-Control Planning Engineer and the Chief Electrical Engineer. This Committee shall prepare general regulations as to the control of water through the operation of reservoirs. In formulating these regulations the Committee shall confer with the Chief Construction Engineer, the Chief Medical Officer, the General Solicitor, and the Superintendent of Power Operations, or their representatives. The regulations shall be transmitted to the office of the General Manager in the form of bulletins for submission to the Board of Directors, and for general distribution after approval by the Board.

2. The Superintendent of Power Operations shall be responsible for the day-to-day operation of the gates within the limits of and consistent with the requirements established by the regulatory bulletins of the committee. He shall [fol. 1205] fix the responsibility for load dispatching and gate operation at each dam. On dams under construction a representative of the construction organization shall be designated to operate the gates.

3. The Engineering data division shall maintain current records of rainfall, run-off, and river flow; furnish daily reports, and predictions; and designate a representative who will maintain daily contact with the Chief Load Dispatcher at Wilson Dam for the exchange of information.

In accordance with this memorandum, S. M. Woodward, Chief Water-Control Planning Engineer, and Llewellyn

Evans, Chief Electrical Engineer, compose the Committee on Water-Control Operations; C. L. Karr, Superintendent of Power Operations, became responsible for the day-to-day operation of the gates; and J. H. Wilkinson, Engineering data division, was designated to furnish daily reports and predictions of rainfall, run-off, and river flow."

I testified that I was consulting engineer on the Miami Conservancy dams in the State of Ohio. I think those dams do a very good job in protecting the City of Dayton. I had nothing to do with putting the following inscription on those dams: "The dams of the Miami Conservancy District are for flood prevention purposes. Their use for power development or for storage would be a menace to the cities below". They were put up after the dams were all finished, but I have seen all of these. There is one at each dam. As an engineer I do not think I would agree fully that that is a correct statement of principle to be applied there.

Assuming that the dams and reservoirs in the TVA Unified Plan are as set forth in the Report of March 31, 1936, to Congress and are to be operated so as to produce 660,000 kilowatts of firm capacity 24 hours a day, and an annual primary output of 5,780,000,000 kilowatt hours, as shown in the table on page 279 of Complainants' Exhibit 115, in a dry year such as 1925, I have an idea how much storage would be required to supply this amount of continuous firm power. I can't give the elevations of the Norris and Hiwassee reservoirs on January 1st, February 1st, March 1st [fol. 1206] and April 1st, that would be necessary in order to provide that amount of firm capacity and firm power in a dry year such as 1925. I do not know from my flood control studies that the storage required to supply that much continuous capacity and output of firm power could not be filled at any time after February 1st until the following fall in the case of a dry year like 1925. I do not know that because I do not know how much storage would be required. I do not think I can answer the question whether, assuming that the storage that would be required before February 1st in such a year would be 3,200,000 acre feet, it would be necessary to have the reservoirs included in the TVA Unified Plan filled up to the normal pool level, such as 1020, for illustration, at Norris, and also to encroach very substantially on the storage capacity above that level. It refers to Fontana Dam and I have not made any calculation. Ex-

cluding Fontana Dam I would want a day or two to calculate in what reservoirs we would put 3,200,000 acre feet of storage by February 1st, assuming the flow conditions of 1925. I am able to solve our flood control problems without being able to answer the question, because in studying flood control we take the wettest year. We don't worry about 1925, which was the lightest year of record in that part of the valley. In studying the flood control we take the wettest year and work down until we come down to the smallest, as far as we think it is necessary to go.

It is correct to say that in any testimony I have given with reference to flood control or flood storage, we have disregarded power production and we have given no consideration to what restrictions would be imposed by any requirement that this system would produce 660,000 kilowatts of firm capacity and 5,780,000,000 kilowatt hours of firm energy annually in dry years such as 1925. I have [fol. 1207] had no idea at all that they would impose any restriction on us in operations.

Examination by the Court:

We gave no consideration as to power requirements in the regulations that we issued for the impounding of water. We do permit them to use that water for power and, in special cases when they might want extra water, if they would ask me about it, we would give extra consideration; and if there was extra water available and they wanted it, we would give it weight and consideration. We would do that the same as we do in many other things that come to us, we give them whatever help we can.

Cross-examination continued:

I have given no consideration in any of my work to the report of the TVA to Congress, as shown in Complainants' Exhibit 115, as to the amount of firm capacity that would be produced by this system and the amount of firm output that would be produced annually. I have never even known what those requirements were. I might have heard these figures, but I don't remember now that I knew of them until they came up here at the trial.

According to my best recollection there was not any Water Control Planning Committee prior to June 30, 1937, composed of myself, Llewellyn Evans, Chief Electrical En-

gineer, L. C. Karr, Superintendent of Power Production, and G. N. Wilkinson, Engineering Data Division. There was no committee that had all four of those men on it. Mr. Evans and I, I think, were at one time denominated a committee, but Mr. Karr was never a member of it nor Mr. Wilkinson.

[fol. 1208] The graph (offered in evidence as Complainants' Exhibit 907) is labeled "Norris reservoir filling curve", and it has a Chattanooga curve on it also. It says approximate discharge, but it has one curve so far as I can see looks as if it could be the Norris elevation curve since it has been in operation. I can't tell in detail except at certain critical points. The outer curve says "discharge". That would take a long time to check back to know whether it was discharge at Chattanooga. I don't think I ever saw that curve before. All I can say is it looks like a Norris elevation curve.

"Mr. R. T. Jackson: I want to offer it in evidence. I would like, if it is not sufficiently identified, I would like to ask the witness if he would identify it.

Judge Allen: He said it would take him a considerable time to check it.

Mr. R. T. Jackson: That is the lower curve, and I am only offering it for the upper one.

Mr. Fitts: Are you offering it or not?

Mr. R. T. Jackson: Yes, I am offering it to show the upper curve.

Mr. Fitts: We object to the exhibit as not identified.

Judge Allen: The Court rejects the exhibit at this time, and sees no particular reason why this particular witness should check this.

Mr. R. T. Jackson: I thought he had a curve by which he could readily check it. May our exception be noted."

In my water regulation work, I have had nothing to do with figuring out how we are going to operate these reservoirs in order to supply the demands of cities like Chattanooga, Memphis, Knoxville, etc., when and if the TVA takes over these cities. But I expect, of course, that this winter is going to be used for water power when it is available so far as it does not interfere with our primary object.

[fol. 1209] It takes the water about 4 or 5 days to travel from Wheeler Reservoir to Cairo. I think the peak stage at

Cairo in 1937 was between 59 and 60 from January 31 to February 6. I don't know the precise dates. I am familiar with the operation of the Wheeler and Wilson reservoirs for the last week in January and the first week in February, 1937.

(At this point, at the conclusion of the day's session, the Court announced that pursuant to request made by defendants' counsel the Court would convene at 10:30 A. M. the following morning, Saturday, December 18, and would sit until the cross-examination and any further examination of the witness Woodward had been completed.)

I think the figures of 9,000 second feet for the average net release from the Wheeler and Wilson reservoirs in excess of the inflow into the reservoirs for the seven days previous to February 1, 1937, are a little large. I cannot get it quite so large. I have computed the average figures for the seven days previous to February 1 showing the excess of outflow from Wheeler over the inflow into Wheeler. I took the figures last night from the curves that I had, and the best I could read them is about 7000 second feet. I do not have the total figures for the excess of outflow over inflow at Wheeler Dam for January 25th. What I did do was to read the storage from the curve as nearly as I could at midnight January 24th, when there was 710,000 acre feet in the reservoir and at midnight of February 1, it was 610,000 acre feet, or a difference there of just 100,000 acre feet in that seven day interval. That corresponds to a little over 7,000 cubic feet per second on the average for the week. It is true that the operation of Wheeler and Wilson Dams made a slight increase in the flood stage of the Ohio and Mississippi Rivers at Cairo on February 4, 1937, by reason of releasing more water than the inflow into those reservoirs, if you leave out the effect of Norris Reservoir, and include solely the operation of those two reservoirs.

[fol. 1210] I consider the operation of Wheeler and Wilson reservoirs in the peak period as fairly typical of the operation and practice which I have been testifying to. If I might explain the circumstances the week of which we are speaking was the critical week in last winter's flood, so far as the Tennessee River is concerned. At the same time the Norris reservoir was retaining the whole flow of the Clinch River. Of course, the Norris reservoir is at a distance of

about 4 days flow of the river upstream from Wheeler reservoir. When I talk about the effect of Norris reservoir, that four days is allowed for. Considering that same period, Norris reservoir was retaining, so far as we can tell, 28,000 cubic feet per second out of the river that would have been at Wilson and Wheeler, and later down at Paducah and at Cairo. The operation during that week on the average was that Wheeler and Wilson released about 7,000 second feet more than was coming in to them. So if that 7,000 is deducted from the 28,000 at Norris, the net effect of the system to reduce the flow was 21,000 second feet. I would like to explain why Wilson and Wheeler were operated that way. The peak in the Tennessee River at Wheeler reservoir and Wilson Dam had come a few days earlier, and the Wheeler reservoir had been operated to keep the top off that peak. In doing that it was filled just as full as it could be allowed to fill. It was up to our maximum level. It could not go any higher without endangering a very important railroad bridge across the river used by two big systems, and a long fill, of which we are under great obligations not to interrupt the traffic. So the reservoir was absolutely full. In doing that, we had protected the cofferdam at Pickwick Dam from being flooded. They were in a very dangerous situation, just the same as at Cairo. The water got to the top of that cofferdam and they sandbagged on top. They did keep the [fol.1211] water out, it was not flooded. It was a very large cofferdam with a lot of machinery. The weather predictions, which we got every day that week, predicted more rain. We were exceedingly worried lest another flood peak would come on top of that and we could not do anything more for anyone. We were making every effort to get a little space in the Wheeler reservoir so we could have a little reserve in there if the flood might come. So, we let out a little more from Wheeler reservoir than came in and lowered the reservoir a little each day, an inch or two a day during that week.

As to whether Colonel Powell, Division Engineer on the Ohio River, protested to me about our releases from Wheeler Reservoir, I heard that he sent a telegram to someone some time. I don't know whether I ever saw it, but I think it was later than that. I testified that I am in charge of the regulation of the water flow. His telegram didn't come to me directly. As to whether a telegram from the

Division Engineer in charge of the great flood on the Ohio River was never brought to my attention, I heard of it and I may have seen it. I know that I heard that he telegraphed. I think it was some time later. I think it was about a week later, but I am not just sure. I presume the telegram was addressed to the Authority and it probably was sent through successive offices down to me. I think probably I saw it, or a typewritten copy of it. I probably advised on the reply that was sent to the Division Engineer and published in all of the papers at the time. I have no record here of that correspondence at all to know whether it is true that the telegram was sent February 1, 1937. If it were February 6th, that is two weeks later than this time after it was all past. Yesterday I said the Mississippi was at the peak at Cairo [fol. 1212] over the period from January 31 to February 6. This critical week was from January 25 to January 30 or 31. I can't say now just how much we knew in advance that that was going to be a critical week. We had all of the data, weather predictions, and we knew it was a very critical week on the Tennessee. We did not know very definitely about Cairo. We tried to get in communication with the officers at Cairo every day. Some days there was difficulty about it. All of the railroad transportation was suspended. It was hard to get communications through, but I think that every day during that whole week we did get in communication with the Cairo Weather Bureau, sometimes by direct telephone and sometimes through the Weather Bureau office at Knoxville or Chattanooga. I think we used the office at Chattanooga because they would have a telephone sometime during the day and then they would relay it to us. But the few wires were so crowded that it was hard to get communications through.

Our operations were in part dictated by our construction work at Pickwick. All of the first part was dictated by that. As the Cairo peak approached, then we did what we could for that. But that was not planned very far ahead. I do not think it is a fair statement to say that we regarded the construction material at Pickwick as presenting a more critical situation than the flood situation at Cairo during that time. But it is true that we were as much surprised last winter by that unprecedented flood as any one else. We had not made any special preparations and, of course,

with only the Wheeler reservoir on the main Tennessee, we can not do but a small amount for Cairo with that single reservoir, and we had not contemplated particularly trying to do that. We would have to have the Gilbertsville reservoir really to be of important use on the Ohio River and the Mississippi.

[fol. 1213] We already had these various gauging stations and things that I have described at length to the Court, but nevertheless we were surprised by this unprecedented flood. Our gauging stations don't go to the Ohio River. That is not in our territory. It is more in the hands of the Army Engineers. My statement was that I was surprised by the unprecedented character of the flood.

"Q. Now, Professor Woodward, you said you did have some information that led you to suspect that there might come another flood, a large flood on the upper Tennessee, is that right?

A. Well, throughout the whole basin the weather—with all of those daily predictions——

Q. I just want to know whether I correctly understood it.

A. Over the whole valley the rains were rather uniform, or at least they covered a great extent of territory in the Mississippi Valley and the Tennessee.

Q. The point I am asking is, didn't you say a moment ago that your operations were also affected by the fact that weather information that you had led you to think that you might have another flood coming along, is that right?

A. Well, an addition on the top—that January flood was a succession of heavy rains lasting nearly a month, and it just built up gradually. If another heavy rain should have come after the last heavy one, we would have had a higher flood still, and that was what we were very much worried about.

Q. Now, I would like to have my question asked, and if you will, please answer that question, Professor Woodward.

A. Well, it was not a separate flood, it would be an added peak on the existing flood.

Q. All right. Let's not argue about it. Did you say that you were, your operations were affected by the fact that your weather information led you to believe that you might have either another flood or an increase in the flood, or whatever you want to call it, is that right?

A. That is correct."

[fol. 1214] I said, when I originally described the prediction system, that we did not predict what the advanced rainfall was going to be. I do not think our system broke down. I think it worked just about as finely as it could have from the information available.

“Q. But working as finely as it could, it still missed the peak?”

The Witness: I think this is a fair statement, that looking back afterwards we can see that we could have had a little bit better control.

Q. And one of the big difficulties is that if we could operate these theoretical systems by hindsight, we could make wonderful records in comparison to what we do when we undertake to outwit nature in advance, isn't that so?

A. Well, we use all of the hindsight we can on the past as a guide to help us in operating.

Q. Yes, but—

A. We never can be 100 per cent perfect or complete in this operation.

Q. And that is because you cannot operate by hindsight, because no past flood is exactly like the flood that comes the next time, is that right?

A. We do operate that way, and I think very successfully.

Mr. R. T. Jackson: Will you mark this resolution which has been produced by the defendants as Complainants' Exhibit 908, please?

Mr. Fly: What resolution is that?

Mr. R. T. Jackson: The one you gave me last night.

Mr. Fly: I have here and I would like to substitute, a complete resolution on that.

Mr. R. T. Jackson: I can't understand that. There is no precedent for it.

Mr. Fly: I object to the incomplete one.”

I was the Chief Water Control Planning Engineer on July 1, 1936, the time when the resolution (offered and received in evidence as Complainants' Exhibit 908) was passed by [fol. 1215] the TVA Board, and I was the official so designated in the paragraph “A Committee on Water Control Operations is created consisting of the Chief Water Control Planning Engineer and the Chief Electrical Engineer”.

"Q. Now, Professor Woodward, yesterday you said that this idea of normal pool level was somewhat of an enigma to you, and I want to direct your attention to complainants' exhibit No. 698, which is the resolution of the Board of Directors of the Tennessee Valley Authority passed August 21, 1936, something like six or eight weeks after the resolution that I have shown you, making you and the chief electrical engineer the ones to pass upon how the water should be let out of these reservoirs, and draw your attention to the fact that the Board in that resolution fixed the normal pool level for Chickamauga Dam, and ask you whether or not the Board did not fix that level upon the recommendation of you and the chief electrical engineer who were the committee charged with the duty of making such recommendations for the approval of the Board as shown by paragraph numbered 1 of the resolution appearing on Complainants' Exhibit 908.

A. No sir, I don't think this matter ever came before our committee. I don't recall any such thing."

It is my testimony that although the resolution, Complainants' Exhibit 908, was passed by the TVA Board, made me and the Chief Electrical Engineer a committee to fix those levels or make recommendations, the action of the Board shown in Complainants' Exhibit 698 was taken without any recommendation from our committee. As far as I know it was fixed without regard to anything that I said or that our committee said. I had many other responsibilities besides this water operation, and the usual procedure is that the tentative plans for these reservoirs when they are made by Mr. Bowman in reports on such matters probably go through my hands and have my approval, and they go from me to the assistant chief engineer as a matter of the engineering planning and construction, and probably I approved these personally. That, of course, was being approved three or four years in advance of the completion of the reservoir and the Committee on Operations was not [fol. 1216] considering matters that far off and have not in any case that I know of ever considered these levels so far ahead. The levels are fixed for the construction operations, for buying land, for helping to determine the land that is to be bought and the line for clearing the reservoir.

Examination by the Court:

We do not prepare any regulations for the control of the water until the dam is completed. We had not considered that until it is about ready for use.

Cross-examination continued:

Mr. Bowman is the head of a division and one of my most experienced and able members of my staff, and is under me, and reports through me. It is our present plan that these pool levels be subject to rather constant fluctuations and that is our practice so far. I, of course, know it to be true that the reservoir of any public utility is subject to daily and week-end fluctuations as a result of peaking for power purposes; that is, where they are permitted to do that. There are some that are not allowed to.

The daily and week-end peaking was limited at Wilson until the TVA built Pickwick,—that is, their capacity was limited because they could not peak the flow so much at Wilson until Pickwick was completed in view of the shallow navigating conditions below the dam.

Mosquitoes that produce malaria breed in the shallow ditches and comparatively stagnant water. When we get these vast lakes built in the Tennessee Valley, the perimeter of shallow water will be much greater than in a state of nature. The language is entirely too strong to say that we will have incubation space for malarial mosquitoes that will [fol. 1217] infinitely exceed any such space that was provided by nature in the Tennessee Valley. As to whether that would be a very large rather than infinite increase in incubation space for malarial mosquitoes, I can not speak very accurately. There are a good many lakes along the bottom lands which remain lakes most of the summer and there have been some very bad mosquito places along the Tennessee River. We are hoping to improve that situation very much. This is a little digression. Our health service is making a lot of experiments trying different methods, and in the two or three years of experimentation we have had, we feel we have had very good results. We have improved a lot of places and we are hoping we can relieve the valley of very much of the trouble in that. As to whether the system the Tennessee Valley Authority has been using on malarial control in the reservoirs is simply the methods

employed by the power companies on such reservoirs for a good many years, we are doing a great deal more than they did. In general, we are clearing up the margins fairly, using various poison methods and fluctuating. As to whether the power companies, under the State Boards of Health familiar with the malarial problem, have been using fluctuation, methods of poisoning and methods of airplane dissemination, for a long time before the Tennessee Valley Authority started doing those things, I do not know that any power company has been making experiments of that kind. I do not know just what efforts have been made. I know experiments have been made by the State Health Agencies. It is not true that as we gradually lower these very large reservoirs, all the damp places and isolated pools of water are left and become excellent breeding places. We drain all those.

[fol. 1218] Assuming the dates marked Sundays on this list from August, 1936, through Sunday, October 4, 1936, is correct, the records that I have show that on many of the Sundays the flow out of Norris Dam was entirely shut off. On some Sundays my record does not show it was shut off at all, and other Sundays it was less, it was partly shut off, or shut off for a part of the day according to these charts. My chart does not indicate any shutting off of the dam at all on Sunday, August 16, 1936. It was shut off for part of the day on Sunday the 23rd. On Sunday the 30th there were some fluctuations, but they were very small, and it was almost the same as a constant flow the rest of the time. On Sunday, September 6th, it was entirely shut off; on the 13th only slight fluctuations; on the 20th it was not shut off at all; on the 27th it was shut off a part of the day. On Sunday, October 4, it was shut off part of the day. On Labor Day, which was September 7th, it was closed until about daylight, shut Sunday, the day before, and it was not started according to this, until sometime in the morning of Labor Day. It is my impression that it is customary for power companies to shut down their hydro plants on Sundays and Labor Day. I suppose the reason they do that is because the industries they serve are shut down and they have no market for so much power. That is common knowledge, no expert knowledge about that.

I testified previously that Norris Dam would be kept at low level, not down to the minimum but down much below the spillway crest until April. Early in January, 1937, Nor-

ris reservoir was down to elevation 990. It was during that flood time that it ran to elevation 1010 on the 17th of January. I think it did not go below 1010 after that time until the summer, until it was filled in June, at which time we brought it up to 1020.

[fol. 1219] The photostat (offered and received in evidence as Complainants' Exhibit 909) of page 515 of Complainants' Exhibit 115, the Hearings of the TVA on the Second Deficiency Appropriation bill of 1937, shows in the upper line the installed capacity, and in the next solid line the firm power capacity at 60 per cent load factor. As you go up from the left-hand on that line on the chart, it goes in a straight line until just before the close of June, 1936. Then it takes quite a steep jump. The title is marked Norris storage, and I suppose means that the steep jump in the line is intended to show the effect of Norris storage on Wilson Dam. That is my interpretation as an engineer. I interpret the curve of firm power with a 60 per cent load factor, which corresponds in general with the steps in the upper curve, "installed capacity" which appears at the beginning of this space "Norris 1," "Norris 2," to mean the bringing in of the generating units at Norris when Norris No. 1 unit was ready to operate. This line fluctuates beginning just a little above the figure 100 on the left-hand side, which is marked "maximum system demand". It goes in a solid line up to a certain point in early 1937, and is thereafter a broken line, which indicates an estimated demand as distinguished from historical or actual demand. I think that is so because there is a date on the chart which exactly corresponds to that place where the line changes from a solid line to a broken line.

The Norris storage alone was sufficient to double the firm capacity of the system at that time. The system at that time was the Wilson plant only. Wheeler was not finished at all. It is my understanding that the storage at Norris will firm up the capacity of the system plants at Wheeler and Wilson and any place downstream, both by increasing the low water flow and also by providing for generation of power at Norris through the release of water in low water seasons. I am [fol. 1220] not a specialist in this field of power, but I think that is true.

I can't say positively that I ever saw a copy of this Complainants' Exhibit 909 before. I have seen various charts of that sort and it is likely that I saw this one. There has

been brought to my attention from time to time charts showing the installed capacity and the firm power capacity, and the system load, and estimates for the future. I have seen more or less of such charts, but my knowledge is very vague because I have never used them or given any particular attention to them. It shows this firm power capacity here with two steps at Norris. That amount of capacity could not be obtained without releasing water through the turbines at Norris. The generators can not operate without water going through them.

I commenced consulting work for the TVA in June, 1933. The plans for Norris Dam were completed by the Bureau of Reclamation. It is true that I visited St. Louis three times, I think, before the drawings that were in preparation there for Norris Dam were delivered to the TVA. It is a fact that in the course of the study of plans for the Norris Dam the Bureau of Reclamation made, among other studies, one of the economic height of Norris Dam. I don't remember the exact title but that identifies the document to me. That document was shown to me and I examined it in the course of my work for TVA. I read it all at one time. I do not have any recollection of how much the figure was which the Bureau of Reclamation reported for the cost of a dam and reservoir at Norris for flood protection alone, equivalent to that included in a power and flood control structure, but I think it was some such estimate as \$7,150,000, or thereabouts in that document. I don't have any idea what the figure was. I have no recollection of that at all. I don't have [fol. 1221] any copy of this report myself. Copies are exceedingly rare because there were not but one or two copies I think ever delivered.

"Judge Allen: The witness has none and he certainly cannot be forced to produce it.

The Witness: It was a report of one officer, one staff member there, and I don't think it has any more standing than his individual opinion. If I might state when that report was being started I was in Denver and consulted with the man that prepared the report and I did not agree with him very well in many things and I never did agree with his report so it doesn't have very much standing with me and I don't think it has any particular official standing. I never did pay much attention to it, I never used it afterward."

I do not mean to testify that the TVA does not have a copy of the report. I think that the TVA has a copy. I don't know what department it is in. We have a central file that are the permanent records, but a great many of the records that are in use are out in some of the offices.

Examination by the Court:

The report was made in the fall of 1933 by a man named Debler. I don't know his title, but he is a man who makes, I think, economic reports on irrigation projects for the Bureau of Reclamation.

[fol. 1222] Cross-examination continued:

These studies were made by the Bureau and the dam was built substantially in accordance with the drawings made by the Bureau of Reclamation.

"Mr. R. T. Jackson: But I would like to have the record show that page 7 of exhibit 113, annual report of the Tennessee Valley Authority for June 30, 1934 sets forth that the Tennessee Valley Authority arranged for the design of the dam by the Bureau of Reclamation, and adopted the name of Norris Dam for the proposed structure. I want the Court to know that I had a substantial basis for inquiring about this document.

The Witness: May I add, I don't know whether the Authority ever asked to have this economic study made or not?

Mr. R. T. Jackson: I suspect not.

The Witness: They may have asked for it. We had a contract with the Bureau of Reclamation, but I am not familiar with its terms.

Judge Allen: Well, if this report is in the office of the Authority the Court will ask to have it produced."

The documents (marked for identification as Complainants' Exhibits 910 and 911) appear to be copies of the information sent out by TVA with reference to the daily river stages and rainfall. We send those out to power companies and anybody that would ask for them. We distribute 150 or 200 copies daily. Of course I have not examined all of the sheets but they appear to be the file.

"Mr. Fly: May it please the Court, in regard to this report of Mr. Debler, as the witness has testified, the Bureau

of Reclamation aided, or perhaps made the entire design of the dams.

Now, as I understand this report of Mr. Debler is his own study as to the economic feasibility of some sort of structure. Now, I have no objection to producing it. I don't think it is relevant here but——

Judge Allen: Suppose you produce it, and then the Court will decide.

[fol. 1223] Mr. Fly: And we reserve the objection? I will be glad to do that.

The Witness: I would like to tell the Court that certain points about the design of the dam which he recommended were not followed. I cannot say how extensive that was."

The releases sent out by TVA with reference to river stages and rainfall, are daily except Sunday. They are not issued on Sunday and the one issued on Monday covers Sunday.

I don't even know who our industrial customers are. I don't know anything about what they do or whether they shut down on Sunday.

Redirect examination:

The document (offered and received in evidence as Defendants' Exhibit 65) is a correct copy of a release of the Board of Directors of the TVA of July 1, 1936, which is a complete copy of the resolution, together with Water Control Bulletins Nos. 1 and 2. I am familiar with them.

"Mr. Fly: And we can state that the certificate, copy of the bare bones of the resolution which complainants offered was erroneously marked as June 30th. July 1st is the correct date. We checked that this morning.

Mr. R. T. Jackson: It is dated July 1st Mr. Fly.

Mr. Fly: Is it?

Mr. R. T. Jackson: Yes. But it seems to me in view of the statement of counsel here, that if it is insufficient to have the bare bones of the resolution we should have an order requiring the defendants to produce all of their minutes, where they have produced resolutions heretofore, instead of just the bare bones, which, as counsel now concedes, shows nothing.

Judge Allen: Well, the Court sometimes decides on the question of bare bones against the wishes of complainants,

and sometimes against the wishes of defendants. The Court [fol. 1224] has consistently excluded minutes which it deems to be immaterial and irrelevant.

The Court considers that these bulletins which are referred to in the body of this resolution are competent, material and relevant, and the Court has permitted complainants against the objection of the defendants, to introduce various tables which were incorporated in a similar way by reference to various resolutions; against the objection of defendants, that was permitted.

Mr. R. T. Jackson: I had interposed no objection here, if your Honor please. It only seemed to me——

Judge Allen: I am just calling your attention to the fact that under this ruling, consistent with this ruling, you were permitted to introduce many papers attached to resolutions. The ruling is exactly the same in each instance.

Mr. R. T. Jackson: I am not arguing about the ruling of the Court.

Judge Allen: All right, let's proceed.

Mr. R. T. Jackson: Well, may I make this statement? I think the concession of counsel changes the situation. That is my only point, and that whether or not the additional material is relevant could not be known to the Court when it was never submitted to the Court.

Judge Allen: The Court has ruled, and its ruling will stand and you may have your exception to the ruling that is against you, and let's proceed with the testimony at this time.

Mr. R. T. Jackson: May our exception be noted with reference to the other resolutions.

Judge Allen: I call your attention again to the fact that this is an irregular session of Court this morning and that we desire to finish."

Mr. Bowman is not a member of the Water Control Planning Committee at all. In fact that Committee does not exist any longer. He never was a member of it when it did exist. He was never a member of the staff engaged upon work having to do with the operation of reservoirs already in operation. Any reports coming through me as to such figures would pertain to construction rather than as to future operation.

[fol. 1225] The greatest height that the Norris reservoir reached during the 1937 wet season was a little over 1031 on

two or three different occasions at that bad flood time. One of the times came a couple of weeks later and we had quite a flood on the Clinch and we had it the same as we had before. It was a little over 1031. We held the flood waters between 1010 and 1031 for a while, but as soon as it was entirely safe we released as much as we could down the river. We drew it down to this minimum of 1010 from the 1031. We arrived at the end of the normal flood season at about 1010.

The TVA does not take the responsibility for the accurate dissemination of information as to the Cairo gauges. We have no authority there, and we have difficulty in getting the information when we want it. It is a long ways away from our places. It was the United States Weather Bureau which was making the predictions of rainfall which I said was equivalent to a prediction of increased flood heights. We get all of those predictions just as fast as they are made by the Weather Bureau office in Knoxville.

My calculations as to the net benefit of Norris and Wheeler combined in reducing the flow out of the Tennessee at time of the crest at Cairo are based on Paducah, which is at the mouth of the Tennessee River, and it has a net reduction in flow at the peak of 21,000 cubic feet per second. It would be about the same amount at Cairo, which is 40 miles downstream. I mentioned in connection with that particular operation of Wheeler that we had a very serious situation on the construction job at Pickwick. They were using sandbags at Pickwick. In releasing that water which was released under those circumstances out of Wheeler, all of [fol. 1226] that water went over the spillway. The power plant at Wheeler, I think, was not running at that time at all. In my opinion, if we had had Gilbertsville and the other dams in operation, we could have attained very much more substantial benefits in controlling the Tennessee at the time of the crest at Cairo.

My instructions fixing the levels or requiring the maintenance of the pools or in discharging the water have never been overruled by the Chief Engineer or by the Board of Directors.

I stated in regard to the Wheeler operation that the normal operation in wet season is to keep it at the minimum navigation level. We have a general plan as to the rate of filling of the Norris reservoir upon which computations of power output could be made. We have what might be con-

sidered a tentative schedule for flood control, which would be specially applicable to a wet year, which is to have the water level as low as 955 by the middle of December, and to be raised during the winter months to 1005 at the middle of April. In a dry winter we think a tolerance of 5 feet over that is perfectly permissible, and it perhaps might be more at times. In a wet winter, whenever we would have much of a flood, we would be at a much higher level because the reservoir fills up during the flood, and then we have to let it out when it can be done safely, and that takes a considerable period, several weeks at times. The five feet tolerance in dry seasons would be without any sacrifices of flood control benefits. We think that is no injury to the flood control when conditions are unusually dry.

With respect to elevations which we regard as desirable and which are presently contemplated for the Hiwassee [fol. 1227] reservoir, we are using for our preliminary planning the elevation of 1415 at the beginning of the wet season, which might be considered December 15th, and 1465 at the end of the wet season, say the middle of April. It will be two years at least before that reservoir will be in operation. During these two years we will carry out a good many more studies of facts and records than we have now made. So this is just a tentative schedule for the purpose of designing and constructing the dam. In my opinion, the plan of filling for Norris Reservoir is feasible at Hiwassee between those stated elevations for purposes of flood control and control of waters in flood seasons. So far as our present knowledge goes, it is perfectly satisfactory for flood control.

Recross-examination:

I have nothing more than I have said as a rule curve for the operation of Norris Reservoir. Rule curve is an expression, as I understand, in power plant operation. It is not one I have ever used. I have an approximate idea what it means. I do not know that I do know exactly all the intricacies. To the best of my knowledge I do not have one. I don't use any such thing.

I don't know at what elevation in a dry year, such as 1925, we will have to have Norris on January 1st, February 1st, March 1st, April 1st, respectively, in order to produce with this TVA Unified System 660,000 kilowatts of firm capacity and 5,780,000,000 kilowatt hours of firm energy an-

nually. As to whether in January, 1925, I could have told that 1925 was going to be a low-water season, I cannot recall about the fall of the preceding year. I do not operate on the theory if the preceding fall is dry the next summer will be dry, but if the ground has been dry a long time, it [fol. 1228] takes a lot more rainfall to produce floods. That is evident all the time in dealing in flood conditions. It is also true rainfall varies from year to year, and that that makes a tremendous difference in flood conditions. You can not tell a month ahead or a year ahead.

It is true that at the present time if we fill Norris Reservoir to the top of the gates, 1034, we would flood out highways, such as the road from Lafollette to Cumberland Gap. When Norris reached the elevation of 1031 in the spring of 1937, we had flooded that road out in places. We were flooding a good many little things around there, it was just entirely too high for proper operation.

(The witness was excused).

[fol. 1229] JOSEPH H. KIMBALL was called as a witness on behalf of the defendants and, having been first duly sworn, was examined and testified as follows:

Direct examination:

I reside in Knoxville and am 64 years old. I am a civil engineer. I received my technical education at the Massachusetts Institute of Technology. For the first period of years I was engaged upon municipal sanitary and hydraulic engineering in municipalities in New England. In 1908 I went to Louisville, Kentucky, and became designing engineer for a portion of the time, acting chief engineer upon the design and construction of a new sewerage system. In 1914 I went to Dayton, Ohio, upon the flood control project of the Miami Conservancy District and served as assistant engineer, construction engineer and assistant chief engineer. In 1924 I went to Cumberland, Maryland, and prepared a plan for flood protection for the city from the flood water of the Potomac River. In 1926 I went to the office of Metcalf & Eddy of Boston, Massachusetts, where I was the assistant engineer and was there until 1932. In 1933 I came to Knoxville upon the TVA work. My position with the TVA is that of principal hydraulic engineer in charge of the

flood control section of the Planning Department. The work has involved the study of conditions in the Tennessee Valley as they affect the flood problem, and the examination of past floods and examination of conditions as they tend to promote floods of the future. The work has also involved a general study of the flood program, as floods have occurred upon other systems.

The data on the map (offered and received in evidence as Defendants' Exhibit 66) was obtained from a comprehensive [fol. 1230] map of the Tennessee River basin, which was, I believe, published by the TVA.

"Mr. Fitts: We offer the exhibit in evidence as Defendants' Exhibit No. 66.

Mr. R. T. Jackson: We object to it, because I do not find that it shows Fontana Dam site on the Little Tennessee River. At least not in the photostat that I have.

Mr. Fitts: That is correct.

Mr. R. T. Jackson: Of course, we object to it.

Mr. Fitts: Of course, it has been our theory all along there is no necessity of showing that on the map. The statement on the legend, 'Fontana Dam site located on Little Tennessee River, recommended by TVA but no appropriation made'. The Little Tennessee River is shown.

Mr. R. T. Jackson: I think it should be shown on the map. It is in your most recent report to the Appropriations Committee.

Judge Allen: Objection overruled. The exhibit will be received.

Mr. R. T. Jackson: May we have our exception noted. And I should like to make this observation, that we have been compelled to show completely everything in regard to the maps.

Judge Allen: Of course, what you did with reference to Fontana, Mr. Jackson, was to indicate the Fontana Dam site on your map with no differentiation between that site, which was merely recommended, and for which no appropriation was made, and the site of dams actually being constructed or actually completed. And since you had it on the map the Court asked you to make a differentiation, which was made. We felt the map was misleading without the differentiation, but in view of this legend the Court allows the map to be received, as not misleading.

Mr. R. T. Jackson: Our objection is upon the ground it is misleading without it, and particularly in view of the fact their latest report to the Congress shows it is a part of the program.

Judge Allen: Objection overruled. The objection goes to the weight and not to the competency."

[fol. 1231] The map (Defendants' Exhibit 66) shows the entire Tennessee River basin with relation to the states which are covered in part by it and with reference to the Ohio and the Mississippi Rivers. The main tributaries of the Tennessee River are shown, the Clinch River, the Holston, French Broad, Little Tennessee and Hiwassee Rivers above Chattanooga, and the Elk River and Duck River, tributaries to the lower basin. The drainage areas of these individual tributaries are also indicated. The principal highways are shown by the white lines. The railroads are shown by the black lines. The location of Norris Dam, which has been constructed, is indicated. The dams which have been constructed, or are under construction, are indicated by the circle within which there is a cross. The dams for which appropriations for construction have been made are indicated by a circle enclosing another circle of smaller size. The dams for which appropriations for investigations only have been made are indicated by the open circles.

The information shown on the tabular statement (offered and received in evidence as Defendants' Exhibit 67) entitled "Rainfall and Run-off", was taken in general from the publications of the United States Geological Survey and from the Mississippi River Commission. It shows first the drainage area of the individual tributaries of the Tennessee River and the average annual rainfall, which has been recorded over the individual basins. At the extreme right also is the average annual run-off. The figures for rainfall and run-off are shown in average inches depth over the watershed. It will be noticed from this that the total drainage area of the upper Tennessee Basin, that is, that portion above Chattanooga, is 21,400 square miles; that there is an average annual rainfall over the basin of 51.9 inches, and [fol. 1232] that the average annual run-off is 24.34 inches. On the lower Tennessee Basin the total drainage area is 19,200 square miles, and the average rainfall slightly more, 52.5 inches. The total for the Tennessee River is 40,600

square miles, with an average annual rainfall of 52.2 inches, and an average run-off of 22.77 inches. In the Mississippi River Basin, the Ohio River, including the Tennessee, has a drainage area of 203,900 square miles. The average rainfall over the total Ohio River is somewhat less than that on the Tennessee, being 44.3 inches. The run-off is also less, being 18.28 inches. The Mississippi River, above Columbus, Kentucky, which is the point a little below Cairo on which principal measurements have been made, the total area there, excluding a portion of the upper Missouri River area, which is arid and does not contribute to floods, is 533,218 square miles. The average annual rainfall is 36.3 inches, and the average run-off only 13.03 inches. From the figures collected it appears that the Tennessee River drainage area is 7.6 per cent of the Mississippi drainage area above Columbus, excluding the arid portion of the Missouri River, but that the mean annual run-off from the Tennessee Basin, compared with that on the Mississippi River, is 13.1 per cent, or nearly double the percentage of the area.

The information on this tabular statement (offered and received in evidence as Defendants' Exhibit 68) headed "Contribution to Clinch and Hiwassee Rivers to Tennessee River Floods at Chattanooga", was obtained from the records of the United States Geological Survey. This table indicates for the principal floods at Chattanooga, for which records are available, the relation of the Clinch River flow and the Hiwassee River flow at points near the Norris Dam and Hiwassee Dam, respectively, with relation to the Tennessee River flow at Chattanooga; in other words, the contributions of these streams to the flood peaks at Chattanooga.

The information on the table (offered and received in evidence as Defendants' Exhibit 69) headed "Contributions of Tributaries to Mississippi River floods", was obtained from the publications of the Mississippi River Commission. This table shows the contributions which have been found in the eight principal floods from the upper Mississippi River at Grafton, which is just above the confluence of that river with the Missouri River; that of the Missouri River; that of the Ohio River as compared with the total flows at Columbus. Between the points of measurement, that is, at Grafton and Hermann, there is an area required to make

the total at Columbus. It will be noticed from this table that the contribution of the Ohio River and the Mississippi floods have varied from 52.1% to 92.1% throughout the latter period, applying to the flood of January of this year.

The information on the table (offered and received in evidence as Defendants' Exhibit 70) headed "Contribution of Tennessee River at crests of more recent Mississippi River floods", was obtained from the records of the United States Geological Survey. This exhibit shows the crest at Cairo for the larger floods as mentioned, and the corresponding Tennessee River flow at the Gilbertsville site. I should say that in making this table the basic data was obtained from the records of the United States Geological Survey, but the estimates as applying to the Gilbertsville Dam site were estimates made by the TVA and the Geological Survey records at Johnsonville. This table shows that the contribution of the Tennessee River has varied from 140,000 cubic feet per second to 475,000 cubic feet per second. [fol. 1234] The data shown on the map (offered and received in evidence as Defendants' Exhibit 71) entitled "Outstanding storms, the occurrence and paths of great rainfall", was taken from the publications of the Government, the United States Geological Survey and the Weather Bureau. The arrows shown upon this exhibit were drawn through the line of principal rainfall during the storms indicated. The length of the line corresponds to the length throughout which there was a rainfall of at least four inches of depth during the storm. It will be noted that the storm of March, 1913, which caused the great floods in Indiana, and Ohio, and Pennsylvania and New York passed north or northwest of the Ohio River. It was most intense over the northern tributaries of the Ohio.

Somewhat in contrast to this was the storm of January, 1937, which passed over the tributaries to the south or southeast of the Ohio River, except on its upper portion. The January, 1937, storm travelled along quite near the axis of the Ohio River, and the rainfall near the river was much greater than upon the outlying portions of the Ohio River drainage basin. Other storms are noted. In October 1910, there was a storm in which the total rainfall exceeded that of March, 1913. This, however, occurred at a time of year when conditions were such as to care for a larger proportion of the rainfall and no damaging floods resulted from it.

That is also true as to the extent of the damage in the storm of November, 1906. That storm was quite similar to that of January, 1937, although it was in a somewhat different location, a little more to the southeast. The storm of March, 1897, is shown as travelling along the Tennessee River basin. That storm produced the maximum flood on the lower Tennessee basin. The maximum flood on the upper Tennessee River occurred in 1867, but rainfall data for that flood was [fol. 1235] not available, so it could not be shown. Then, it is interesting to note, though, that the 1867 flood, which was the greatest in the upper Tennessee River, and the March, 1897 flood, which was the greatest on the lower basin, caused the third and fourth highest stages at Paducah previous to the 1937 flood. Another storm indicated is that of March, 1917, which produced the greatest flood on the upper Tennessee in the last 50 years. The storm of March, 1929, is also indicated. That storm had some definite peculiarities. It was at several points along its course a storm quite different in type to these others. It produced cloudburst rainfalls in the neighborhood of the upper Tennessee where it came nearest to the basin. There were cloudbursts of rainfalls in which at some points as much as 11 inches of rain fell within the period of only about four or five hours. That storm did not cause general flood conditions on the upper Tennessee River basin. There was no flood at Knoxville, nor on the upper Holston or French Broad, or Little Tennessee.

Similar storms of the cloudburst type might be mentioned. There was one which occurred in 1924 in Carter County, which is in the northeastern part of the Tennessee drainage basin. In that case there was a rainfall of about 15 inches in three or four hours. In that storm the rainfall came in such torrents that it caused a number of landslides, and produced scars on the hillsides which are visible today. That washing of material from the hillsides was somewhat like that which occurred in the 1929 flood. In this flood there were landslides which washed a vast amount of earth over the railroad tracks, in one case pushing a locomotive and tender off the track into the river. That type of cloudburst storm is more or less local in nature.

I want to mention also another storm which is not mentioned here, and that is one which occurred in 1916. It caused a rainfall of 22 inches in one day, very

near the divide between the Tennessee River basin and the area of drainage into the Atlantic Ocean. That record, at the time it occurred, was the most intense rainfall which had been recorded east of the Rocky Mountains. As stated, these types of storms are likely to produce cloudbursts anywhere, and without warning. The damage resulting from those would be generally very local. In the case of this 1916 storm to which I referred, the greatest flood was caused at Asheville on the French Broad River, but there was no flood at Chattanooga, at the time when the flood waters reached that point.

The flood season on the Tennessee ranges from about the middle of December to the first of April. There have been no substantial floods at Chattanooga after the first week in April, and all of those were caused by rains which fell in the last of March. The flood season on the Mississippi extends a little later, perhaps a month later, because of the time required for the flow to reach the Mississippi from the headwaters of the Ohio. The upper Mississippi River also contributes generally its largest contribution late in the spring or very early in the summer at the time when the Ohio River floods are much less.

The chart (offered and received in evidence as Defendants' Exhibit 72) is entitled "Chattanooga as now developed under 1867 flood conditions". The flood heights were obtained by data collected by the United States Army Engineers Corps and by the city engineers of the City of Chattanooga. The elevation of the land which was necessary in order to show the extent of the flood waters was obtained [fol. 1237] from surveys of the TVA. This exhibit shows the extent of flooding in the City of Chattanooga, showing the greatest flood of record, that of March 11, 1867. It covered all of the lower industrial area of the city and a large part of the commercial and business section. It will be noted that the flood waters extended over Market and Broad Streets, which are the principal business sections of the city. The industrial section was well submerged. The map on which this flooding appears is a map showing present day Chattanooga. The outline of the water, of course, is the outline of the water as it occurred in 1867.

The data shown on the map (offered and received in evidence as Defendants' Exhibit 73) entitled "Chattanooga as now developed under 1917 flood conditions", was supplied

by the United States Geological Survey, together with surveys of the TVA as indicated for the previous exhibit. This shows in the same general way the extent of the flood water which occurred March 8, 1917. The elevation of the water in this flood was about ten feet less than in the previous flood. This was the greatest flood in the last 50 years.

The photograph (offered and received in evidence as Defendants' Exhibit 74) labeled "Chattanooga, Tennessee, View from Lookout Mountain, Flood, March, 1917". This photograph was taken by a local photographer. In the foreground, about the center of the picture, are shown some industrial plants which are within the flood waters, and these industrial plants are also seen a little to the left, also within the flood. Various spots can be seen on the upper right hand corner representing the housetops as they appeared above the flood. In some cases, following the lines of these houses, the locations of certain streets can be traced. The line extending from the curve at the right hand margin upwards and to the left is the Southern Railway as it appeared in the flood. At the left hand side is the N. C. & St. L. Rail- [fol. 1238] road. The Central of Georgia Railroad is not visible on the photograph. That was near the margin of the flood water, about the center of the picture. The water that is shown there on the picture is valley storage. In the 1867 flood the water was 10 feet higher than is shown on this photograph.

The photograph (offered and received in evidence as Defendants' Exhibit 75) is a view of Chattanooga from the top of Lookout Mountain showing conditions as they are today. This photograph was taken about a month ago by a photographer in the employ of the TVA.

Cross-examination:

The only significance of the difference in shading to the right hand side of the railroad tracks is that some photographs were pasted together. The camera did not have a wide enough angle to take in the full panorama in one view. There were two or more views taken and those were placed together in this reproduction.

Direct examination continued:

The photograph (offered and received in evidence as Defendants' Exhibit 76) is a view of United States Highway

11, the road running from Chattanooga to Cleveland, and a portion of the highway which I believe extends from Quebec to New Orleans, the main highway from north to south. The view is taken a little east of Chattanooga. The bridge in the center is the bridge over South Chickamauga Creek. The arrow which is held on the pole at the left hand side of the road represents the height of the flood water in the flood [fol. 1239] of 1867. The photograph was taken by a photographer in the employ of the TVA. Some of these photographs were taken a year ago, some recently. The dates are marked on each and this was taken December 7, 1937.

"Mr. R. T. Jackson: My only objection to it is on the ground it is misleading because the photograph is not taken on the level of the supposed mark on the telephone pole, but taken on a lower level, slanting up. The Court would think that the flood very shortly overtopped that next tree, and flooded the landscape from there on. Of course, if they wanted to take an accurate picture, it should have been taken from the level on the flood.

Mr. Fitts: It is perfectly obvious, to show a point on the highway where a flood like that of 1867 would reach today.

Mr. R. T. Jackson: This is 1867?

Mr. Fitts: This is the high water mark of 1867 flood.

Mr. R. T. Jackson: Oh, I didn't realize that. I thought it was the flood of last year, and that somebody was taking an actual picture with some added data there.

The Witness: I might say further that the pole on which the arrow is placed is a graduated pole and the flood depth at that point can be read from that pole."

We surveyed it carefully, levelled from marked points of flood elevation to each point where the photographs were taken and on the flood heights allowances are being made for the slope of the water surface as found from the records of the Corps of Engineers. The survey was made by employees of the TVA under my general direction. I think I stated it was taken from the record of the marks collected by the Corps of Engineers and by the City Engineer. I saw those which had been taken. They were taken by employees under my general supervision and direction.

[fol. 1240] Cross-examination:

I cannot say how close to this telephone pole we had any mark. The allowance for the slope of the water was made

from the point where the marks were available. They knew what the slope of the water was because there were a sufficient number of the water marks recorded and collected by the Corps of Engineers to indicate the slope of the water in this flood. There was a great deal of study made on this subject. The employees of the Corps of Engineers spent a great deal of time and our own employees spent a great deal of time in identifying and getting what was the most reliable data on the depth of this flood. I don't think it is true that no matter how much study had been made that study lead to a wide divergence of opinion among the different people.

Direct examination continued:

This represents my own judgment as to where the water was in the flood of 1867.

Cross-examination:

There is a permanent monument in Chattanooga that shows where the flood was in 1867, but I don't remember the location right now. That permanent mark was placed there by the late Mr. Hooks, City Engineer of Chattanooga. I talked to him previous to his death and he explained to me how that mark was made. It was one of a number of marks. The other marks were selected by the Corps of Engineers. The mark that was actually left in the 1867 flood was on a building which was removed. Mr. Hooke, [fol. 1241] in order to preserve that record, transferred with surveying instruments that mark to the corner of a masonry brick or stone building here at Chattanooga where the mark still exists. Mr. Hooke told me when that was done, but I don't recollect now the date that he gave. Mr. Hooke was quite an old man. I stated that Mr. Hooke was an old man to show his actual information extended over a considerable period. I don't remember when he said he made his transfer of this mark. The building may have been about four miles from the point shown in this picture.

"Mr. R. T. Jackson: I made an objection upon the ground the way the picture as taken is misleading, in the first place, because it is taken with the camera held below the mark, tilting upward. I do not mean purposely to create, but it certainly results in creating, a misleading impression

as to the surface of the flood. Secondly, there is no evidence that this mark upon the telephone pole is reliably fixed in relation to the flood of 1867.

Mr. Fitts: We offer the photograph in evidence as Defendants' Exhibit 76. In my opinion, certainly, the objection as to the misleading character is frivolous and it could not possibly be misleading. It shows the number on the pole and shows the exact location.

Judge Allen: The objection is overruled. The exhibit is received as a demonstration of the witness' opinion.

Mr. R. T. Jackson: Exception."

Direct examination continued:

The photographs (offered and received in evidence as Defendants' Exhibits 77, 78, 79, 80) showing the railroad tracks (Exhibit 77), a factory with highway 41—64 (Exhibit 78), the substation of the Tennessee Electric Power Co. (Exhibit 79), and the Union Depot of the N. C. & St. L. Railway (Exhibit 80) are subject to the same explanation which I gave with respect to Defendants' Exhibit 76.

[fol. 1242] "Mr. Fitts: We offer exhibits 77, 78, 79 and 80 in evidence.

Judge Allen: Any objection.

Mr. R. T. Jackson: Well, I object particularly to 79 because I think again the way the photograph is taken is misleading."

Examination by the Court:

The dimensions of this flood marked as the flood of 1867 are correct according to my knowledge. I have seen and examined this cross, whatever it may be called, with the height of the 1867 flood, and it is correct according to my knowledge of the flood heights.

"Judge Allen: Exhibits 77, 78, 79 and 80 are received in evidence as illustrations of the witness' opinion.

Mr. R. T. Jackson: Exception, please."

Direct examination continued:

The chart (offered and received in evidence as Defendants' Exhibit 81) is entitled "Floods, Chattanooga, Tennessee, types of property, affected, 5 foot intervals of river stage". The chart as to flood heights was taken from the

records of the United States Geological Survey, and the general classification of property was made from an inspection of the areas, and the individual points, such for example, as Seventh and Market Streets, 52.8, were taken from the surveys of the TVA. This exhibit was prepared to show the types of property which were affected with the succeeding increases in flood depths. The flood stage at Chattanooga is called 30 feet. Immediately, as the flood water rises above 30 feet, certain low buildings indicated in the center of the third band from the bottom are reached. The flood of that depth, between 30 and 35 feet, reaches United [fol. 1243] States Highway 41-W, as shown in the left hand side. This stage also affects the Chattanooga and Northern Railroad and the Central of Georgia Railroad. The next band, between 35 and 40 feet, extends so as to reach several of the important industries, and that also reaches other tracks of the Central of Georgia Railroad. Proceeding upward, when the stage between 40 and 45 is reached, Highway 11 becomes flooded, and additional industries are reached, and, of course, to a greater depth for those that had been reached previously. In like manner it is shown that the Southern Railway and the N. C. & St. L. Railroad are reached on stages between 45 and 50 feet. The N. C. & St. L. Railroad station is reached between 50 and 55 feet, and Market Street is pretty well covered through the 55 to 60 foot stage. In Mr. Kurtz' hypothetical flood, which he estimated to reach a stage of 73 feet or more, that depth would be about 12 feet above the corner of 9th and Georgia Avenue, and the first floor of the Patten Hotel would be quite damp.

I have examined Complainants' Exhibit 349, with respect to which Mr. Kurtz testified that it set forth the findings of the Army Engineers as to flood damage in the Tennessee basin and which was used for the purpose of determining the location of the various types of damage and the principal amount of damage. That estimate, which was the estimate of the Corps of Engineers in House Document 328, did not include any elements of intangible damage such as interruptions to business and transportation, sickness, damage to public health, loss of wages, and whatever general depressive effects of floods there may be. There are certain conditions where a statement of the damage to property is a true indication of the damage that the flood causes. In

other cases, that comes very far short of indicating the dam-[fol. 1244] age that has been caused. The flood causes a certain damage always necessitating cleaning up or removal of mud and the repair of any actual destruction which is caused by the flood, and also loss of furniture or goods or whatever might be spoiled by the flood waters. A flood of the proportions of the flood of 1867 would completely suspend any movement of commerce through Chattanooga.

I have examined Mr. Kurtz' testimony concerning flood damage upon the Emory River and particularly at Harriman. The significance of that is that it illustrates what may happen to any point within the Tennessee Valley where rainfalls of cloudburst proportions occur. The flood at Harriman was, as I understand, the only serious flood which has ever been recorded. That occurred in 1929. The Railroads have been in operation for a period of about 50 years before that time, and have never been seriously affected previous to that time. The railroads, according to the estimates of the Corps of Engineers, were sufferers to the extent of about 50 per cent of the total damage in that flood. That flood, however, is one which may occur at any point, and it has limited significance to the work of the TVA, in which, as we understand it, our duty is to construct dams and reservoirs which will have a general benefit rather than local benefits. In the case of Harriman, if the situation at Harriman were to be corrected, that would be like stopping a leak at any one point which might break out anywhere within the valley at some future time. That storm started as a thunder-shower, and, as is commonly stated, lightning strikes anywhere and seldom twice at the same point.

The Clinch and Hiwassee Rivers are substantial contributors of flood peaks on the Tennessee. Norris and Hiwassee Dams will retain the flood water during the crest of the flood at Chattanooga. Subsequent to the crest, the water can be [fol. 1245] released when it will not do any damage, in order to provide space for further floods.

The function of the main stream dams above Chattanooga, which hold in storage a certain volume of water for navigation, will be to release a substantial amount of this storage at the beginning of the flood, and then later, as the critical time comes, the gates will be closed to reduce the peak, and then the surplus water held in the surcharge area will be released as soon as feasible, the function thereby being to even off the flood crest. The further function is that each of

these main stream dams will clip off the top of the flood peak, and as the flood water progresses, the successive portions of the peak will be taken off and the burden on the lower reservoirs in controlling the Mississippi River floods will be reduced by the removal of such portions of the flood water in all of the dams above.

In my opinion, in order to obtain a substantial degree of flood control upon the Tennessee River, it is preferable to construct combinations of storage reservoirs upon the tributaries of the Tennessee and high dams with surcharge storage upon the main stream of the Tennessee and in my judgment this combination is essential.

I have made studies and computations as to the amount of reduction in flood heights at Chattanooga in the previous floods which could have been obtained by the operation of the dams constructed and under construction, and Watts Bar and Coulter Shoals which are being investigated for construction.

The table (offered and received in evidence as Defendants' Exhibit 82) shows estimates of reductions in peak discharge and reduction in flood crests at Chattanooga for various systems of reservoirs. The estimates were based upon records of stream flow as given by the United States Geological Survey and the reductions are estimated from data as to the reservoirs under construction, which was procured as noted, and the various characteristics of the channels and the flow therein. The estimates of reductions were made by taking account of the capacities available for storage and applying them to the actual day-to-day flow of the river as recorded, and the effect of the channel capacity as influencing this flow.

The estimate of reduction is made with reference to the 1926 flood, the 1936 flood and the 1917 flood. It is estimated that with Norris and Hiwassee reservoirs in operation, in the 1926 flood, the peak discharge of 252,000 cubic feet per second at Chattanooga could have been reduced to 190,000 cubic feet per second. Similarly, the flood of 1917 could have been reduced from 332,000 cubic feet per second to 265,000 cubic feet per second. With the addition of the Chickamauga reservoir, the reductions would have been further reduced as shown in the table. And with the further addition of the proposed Watts Bar and Coulter Shoals reservoirs, the peak flow could have been reduced to the

figures shown at the bottom of the upper table. The reductions in flood crest are given in the lower part of the sheet. The 1926 flood is shown there as being reduced from a peak of 38.4 to 24.6 feet. Referring to Defendants' Exhibit 81, that would result in a reduction of the height below flood stage at Chattanooga and would make the difference, in other words, between a flood and no flood. The flood stage at Chattanooga is 30 feet as indicated, and in those cases where the reduced stage is below 30 feet, the flood is eliminated. In the case of the 1917 flood, the total reduction is from 47.7 feet to 32 feet. That reduction would eliminate the damage to the various types of property between the [fol. 1247] 32 foot stage and the actual stage of 47.7.

These floods which are noted here, we used because the data was sufficient for the making of the estimate. The greatest floods in the Tennessee Valley occurred before the records were kept to any substantial extent. It was, therefore, impossible to estimate reductions which could have been made in those early floods. The records are scanty for sometime after 1900. The 1917 flood is really the earliest flood for which we could make reliable estimates.

Although the works now provided for will not eliminate the greatest floods which have occurred, such as 1867, these reservoirs will reduce such floods very substantially, and as pointed out in the Unified Report, with desirable storage upon the other three tributaries, the Little Tennessee, the French Broad and the Holston Rivers, a degree of reduction would be attained which would bring the flood problem in Chattanooga within the reach of the City. With the projects now provided for and recommended, that is, Norris, Hiwassee, Coulter Shoals, Watts Bar, and Chickamauga reservoirs, the greatest flood within the last 50 years would be practically eliminated, and I think that is a substantial result. These reservoirs which I have named will be useful in reducing flood peaks or the passage of the wave down the river, and further in modifying the peaks on the Ohio and Mississippi Rivers.

The chart (offered and received in evidence as Defendants' Exhibit 83) entitled "Mississippi River hydrograph 1929 flood", represents the hydrograph of the Mississippi River flow at Cairo during the 1929 floods. This was not one of the very serious Mississippi River floods, and this was not a flood to which the Tennessee River made great contribu-

[fol. 1248] tions. The flood heights at Cairo in the past floods on the Mississippi have almost without exception been influenced by levee breaks below, and in order to get a real picture, this case was taken because this was a flood that was contained entirely within the levees and represents a typical hydrograph of actual flow. It has been thought in the past that in order to control a flood, it is necessary to control or hold back perhaps the entire flood flow. This exhibit is introduced to point out that by holding back a comparatively small amount of the total flood volume, very substantial reductions can be made in the height of the flood. For example, in reducing the Cairo stage from 52.7 feet to 52, it was necessary only to deduct about 710,000 acre feet, or about .24 of 1 per cent of the entire flood volume. To reduce it another foot required the control of only 1.03 per cent; to control it 2.7 feet required only the control of 2.33 per cent; and to control to a stage of 3.7 feet below the crest, 4.4 per cent. Comparing those figures with figures for the recent flood in 1937, the percentages appear quite comparable. To reduce the stage in 1937, .8 feet, requires the control of only about .35 of 1 per cent of the flood volume. To reduce it 1.8, the control of 1.23 per cent; and to reduce it 2.8 feet, the control of 2.45 per cent; and the further reduction to 3.8 feet to control 3.95 per cent of the total flood volume.

“By Mr. Fitts:

Q. Mr. Kimball, I will ask you whether or not in your opinion it is practicable to reduce flood heights on the Mississippi River below Cairo by the provision of a substantial amount of storage on the Tennessee River System under the plan as outlined in the so-called Unified Report to Congress of March 31, 1936?

Mr. R. T. Jackson: I object to that because we have no proof here of any action by the TVA Board as to how the reservoirs are to be kept. It is impossible to answer without that.

[fol. 1249] Judge Martin: Isn't that in the plan?

Mr. R. T. Jackson: I think it is not, your Honor.

Mr. Fitts: The record is full of testimony on the subject.

Judge Allen: The objection is overruled.

Mr. R. T. Jackson: May we have our exception, please?

A. It is.

By Mr. Fitts:

Q. Would it still be possible to produce that result if you exclude Fontana?

Mr. R. T. Jackson: The same objection, of course.

Judge Allen: The objection is overruled.

Mr. R. T. Jackson: Exception.

A. It will be possible to produce that result, but to a slightly smaller degree."

The function of the storage reservoirs, such as Norris and Hiwassee, will be to store the water during the critical period, and the function of the main stream reservoirs will be to clip off the crests, as the flood wave passes through the successive reservoirs, removing in each case a portion of the flood volume and reducing the burden on the lowest reservoirs, the lowest of which will be the direct agency in reducing the crest upon the Mississippi. It is my judgment that a very substantial reduction can be made in that way. In my opinion, it is best for Mississippi flood control to obtain the combination of high dams on the main stream of the Tennessee and storage dams on the tributaries of the Tennessee. Each one supplements the other in its effect. The storage reservoirs reduce the volume which has to be handled by the river dams, and the river dams in turn, serve to regulate the out-flow from the storage reservoirs, or the reduction which they have accomplished, and produce more definite results than could be obtained by the use of the tributary reservoirs alone, more certain results.

[fol. 1250] I have made studies and computations as to the amount of reduction in past flood heights on the Mississippi that could have been obtained by the operation of the reservoirs. In the 1912 flood, through the operation of the TVA system, the Cairo stage of 53.94 feet could have been reduced to 51.44, a reduction of 2.5 feet; in the 1913 flood a reduction in the Cairo stage from 62.5 feet to 60.2 feet, a reduction of 2.3 feet; in the 1927 flood, a reduction of the Cairo stage from 58.5 feet to 56 feet, a reduction of 2.5 feet; and in the 1937 flood a reduction at the Cairo stage from 59.5 feet to 57.6 feet, a reduction of 2 feet. I might say in explanation of this that the maximum stages given were crest stages estimated by the Mississippi River Commission. The actual stages, which resulted from the breaks in the levee system, permitted lower stages, but with a com-

plete levee system the stages given would have been obtained. In my judgment, reductions such as those which I have estimated are of very substantial value in protecting the Mississippi Valley. In my judgment, it is wholly reasonable to expect similar reductions can be made in future floods at Cairo, similar to those which have been indicated. The reduction in the 1937 flood was estimated to be 2 feet. That is, from 59.6 feet to 57.6 feet.

I have prepared a study regarding the relative times of the peak flows in the lower Tennessee River and of the Ohio and the Mississippi Rivers.

The tabular statement (offered and received in evidence as Defendants' Exhibit 84), is entitled "Data of Flood Peaks at Johnsonville on the Tennessee River, Paducah on the Ohio River and Cairo on the Mississippi River for past floods exceeding 50 feet at Cairo". The data was obtained from the records of the United States Geological Survey. It will be noted that the peak stage at Johnsonville in the 1884 flood was estimated. The hydrograph of the Tennessee River flood in 1884 as recorded varied somewhat from the [fol. 1251] ordinary relations which the hydrographs have in other floods to the stages above and below, and it was found that those records in that one instance were kept by an attendant who failed to record them correctly, and for that reason we have made an estimate, studying the contribution of the flow from the tributaries and the rainfall and estimated the peak as it probably was in Johnsonville at that flood. In my opinion, based upon the information contained in that table, in most cases the Tennessee River peak reaches the Ohio River before the peak on the Ohio arrives from upstream.

The basic data in the table (offered and received in evidence as Defendants' Exhibit 85) headed "Tennessee River flood flow at Gilbertsville Dam site, flood of January-February, 1937", is from the Geological Survey records. The second column shows for each day during the flood period of 1937 the stage on the Ohio River at Paducah. Following that in the next three columns are the Tennessee River flows. The inflow to the river is to be distinguished from the actual river flow.

[fol. 1252] Cross-examination:

This is the Paducah gauge. There is a gauge at Gilbertsville at the present time but this stage referred to is the

Paducah gauge and there is no reference to any Gilbertsville gauge. I do not have the zero of the Paducah gauge here.

Direct examination continued:

I would like to say in explanation of the three columns showing the Tennessee River flows, starting with the low flow in the river, when the increased flow comes down which produces a flow ten times that which was carried previously by the river, in order to take this flow ten times the existing flow, the flow in the river must be increased in velocity ten times, or there must be a volume if the velocity is to remain the same, which is ten times as great. What happens, of course, is that the velocity is increased somewhat, and the volume swells to considerable proportions. In the case of a narrow gorge the principal change is in the velocity. In a broad, open area, the principal change may be in the volume of water. The first column represents the flow as if it were carried in a pipe line, that is, if the velocity were speeded up sufficiently to carry the entire amount. The second column represents the conditions as they actually were, that is, in that case the velocity has been increased and the volume has been greatly increased. As the volume has increased, it causes what has been called valley storage, and that valley storage is indicated in the third column, being the difference in each case between the amounts stated in the first and second columns. As we pass down, we come to the stage on January 28th, when the peak in the Tennessee River was reached. At that time the water over the flood plain was at its maximum height and subsequent to that time the water [fol. 1253] commenced to run out from the flood plain, or in other words, the valley storage was released. In the last column is shown the release of the valley storage. It will be noted that this release ranges between 34,000 feet per second on January 28th, and a maximum of 92,000 on February 3rd, and fell then to 45,000 on February 9th. The Ohio River crest at Paducah was on February 2nd, and the tabulation shows that in this Ohio River flood crest period, the Ohio River was swelled by the release of valley storage from the Tennessee. In my opinion the operation of this so-called valley storage on the lower part of the Tennessee River increased the flow in the Ohio and the Mississippi Rivers by a maximum of about 92,000 cubic feet per second.

The line at the top of the diagram on the chart (offered and received in evidence as Defendants' Exhibit 86) entitled

"Effect of natural storage in Gilbertsville Reservoir area in the flood of 1937," shows the rise in the Ohio River at Paducah from day to day. In the lower half of the diagram in a black line is shown the actual flow, and the red line indicates the flow that it would have been if it had been confined to a pipe line. The red line crosses the black line at the point where the valley storage is at the maximum. On the left of this point the water was increasing in the valley storage and on the right the water was running out of the valley storage, and it will be noted that this release is shown by the area between the black and red lines at the right of the point where the two lines cross. That amount is contributed and forms a part of the Ohio River flood water at the crest at Paducah. In other words, it is fair to state that in this particular flood, the water which had been retarded and held back by the natural valley storage was released and discharged at the very time it coincided with the peak on the Ohio River.

The elevation of the area marked "dead storage" on Complainants' Exhibit 411, which was introduced by Colonel Kelly, is shown to what is designated as "minimum [fol. 1254] pool". The elevation of "minimum pool" is shown on page 82 in the Report on the Unified Development of the Tennessee River System. On this page there is an elevation of water above the dam indicated as "minimum headwater elevation." The illustration represents the Guntersville Dam. Below this elevation there is shown the area which is covered by the small dots, the actual spillway, and the spillway crest is indicated there in this case as at elevation 555. The terms "minimum pool" and "minimum headwater elevation" are synonymous. They mean the minimum elevation in the pool, for when the pool is level, necessary for a 9 foot navigation plan. The spillway is shown in the section of the Report on the Unified Development to which I have referred and this picture shows the difference in elevation between the maximum pool which, in this case, was at elevation 590, and the spillway crest at elevation 555, a difference of 35 feet.

The chart (offered and received in evidence as Defendants' Exhibit 87) is entitled "Elimination of Dead Storage".

"Mr. Fitts: We offer in evidence as Defendants' Exhibit No. 87 the chart entitled 'Elimination of dead storage' which has just been discussed by the witness.

Mr. R. T. Jackson: We object because it shows among other things Gilbertsville at an elevation of 375, which is contrary to the last report in Congress.

Mr. Fly: Do you have the evidence?

Mr. R. T. Jackson: I expect you to produce it. You said you would.

Mr. Fitts: The point is in this case the testimony is that elevation 375 has been decided upon.

Judge Allen: The objection is overruled. The exhibit is received.

Mr. R. T. Jackson: May we have our exception."

In the upper right hand sketch on Complainants' Exhibit 411, described by Colonel Kelly, there is an area colored in light blue which is marked "dead storage". In the lower right hand sketch on Defendants' Exhibit 87, this same area [fol. 1255] is marked in red and there it is indicated "valley storage eliminated". The exhibit which I have prepared, on the upper half of the sheet, shows the elimination of valley storage, as he has portrayed it in the lower right hand sketch. In the bottom half of the diagram is a sketch or drawing which shows the red area restricted and the volume within the reservoir below the top of the spillway as described in Colonel Kelly's verbal testimony. It will be noted that throughout the series of dams there is a very marked difference in these red areas between the upper drawing and the lower drawings, with the exception of Hales Bar Dam and reservoir. In that case there are no gates which may be opened releasing water to a low depth in the reservoir as provided in the TVA dams. The lowest sketch represents that in place of the dead storage indicated above, with the gates open, which extend down to the top of the spillway, the dead storage is replaced by actively moving flood water. When it is necessary or desirable to control the peak, the gates may be closed and the volume back of the gates up to the maximum or surcharge elevation can be retained and stored.

The expression "AF" on Defendants' Exhibit 87 means acre-feet. It is fair to state that what I purport to show on Defendants' Exhibit 87 is that, according to Colonel Kelly's diagram which he introduced in evidence as Complainants' Exhibit 411, the amount of valley storage eliminated by the so-called dead storage would be the amount represented in the upper half of my chart and that when I take his testi-

mony on both direct and cross-examination defining dead storage, the amount of valley storage eliminated is the amount shown in red on the lower half of my exhibit. I testified with respect to the computations of flood reductions on the Mississippi in various floods since 1900. In my opinion those computations properly represent the relative advantage of reservoir storage on the Tennessee against the so-called natural storage in the 1937 flood.

[fol. 1256] "Q. Mr. Kimball, I have handed you Complainants' Exhibit No. 352, which according to the testimony of Mr. Kurtz is the general map of the general layout of the reservoir system proposed by him. I have also handed you Complainants' Exhibit No. 353, which is a tabular statement of engineering data on the system of flood control to achieve a maximum practical flood protection, offered during the testimony of Mr. Kurtz, which shows the streams on which reservoirs are located, the tributary drainage area in square miles, the gross storage volume in acre feet, the net storage volume in acre feet, the estimated construction cost and the lands flooded when water is at spillway level in acres. I now ask you, including the construction and operation of 19 detention reservoirs, four located on the French Broad and its tributaries, five located on the Holston and its tributaries, two located on the Little Tennessee River, one located on the Clinch River and three located on the Emory River and its tributaries, the specific locations being shown on Complainants' Exhibit 352, assuming that these reservoirs would be operated solely for flood control, being kept empty to catch flood waters only in event of floods of certain capacity; assuming further that these reservoirs have two classes of openings, one being conduits which were kept open, the other with gates operated automatically; assuming further that the reservoirs would be operated so as to maintain at all times while the reservoir is being filled a constant flow through the total area of the openings; assuming further an automatic schedule which would cause the gradual closure of the gates, in those openings which are provided with gates, thus closing the flow of water from these dams through those openings; and assuming further tributary reservoirs at designated points where all of the gates would be open and the entire amount of flow would be passing through the openings without gates, assuming for each reservoir the rate of natural emp-

tying would be fixed by automatic schedule not subject to human control; assuming further that the tributary drainage areas and the storage capacity of each of these different reservoirs would be as shown on Complainants' Exhibit No. 353, further assuming that the continuous rates of release when the reservoirs are filling would be as follows: Painter Creek 22,400 cubic feet per second, Solomon Ferry 42,000 cubic feet per second, Dandridge 65,000 cubic feet per second, Kikers Ferry 60,000 cubic feet per second; Island Mills 2,000 cubic feet per second, Bachman Ford 24,000 cubic feet per second; Surgoinville 36,000 cubic feet per second, Three Springs 35,000 cubic feet per second; Strawberry Plains 40,000 cubic feet per second; Fontana 50,000 cubic feet per second; Davis Ferry 60,000 cubic feet per second; Cove Creek 20,000 cubic feet per second; Frankfort, 2,500 cubic feet per second; Milliken Branch 16,500 cubic feet per second; Wartburg 250 cubic feet per second; Coleman 29,000 cubic feet per second; Apalachia 21,000 cubic feet per second; Austral 16,000 cubic feet per second; Charleston 46,000 cubic feet per second; I will ask you on [fol. 1257] those assumptions to please state whether in your opinion such a system could be successfully operated to reduce flood peaks on the Tennessee and Mississippi Rivers?

Mr. R. T. Jackson: I object to the question on two grounds. First, it does not state the rainfall or the extent of the run-off. Second, it relates to the Mississippi River and Mr. Kurtz' flood control was for the protection of Chattanooga and above, as he testified.

Mr. Fitts: Don't I have the right to ask the witness the question, with the hypothesis for the question being the entire testimony of Mr. Kurtz.

Mr. R. T. Jackson: It does not pertain to the run-off.

Judge Allen: Where is the run-off found in the evidence?

Mr. R. T. Jackson: I have not the page. I know there was an eleven inch rain in a three day period.

Mr. Fitts: You are talking about a super flood. I am asking on the basis of your own evidence.

Judge Allen: He may answer.

Mr. R. T. Jackson: May we have our exception.

A. In my judgment it could not be operated successfully for those purposes.

Q. Will you explain your answer?

A. The reservoirs as indicated cannot be adapted for the varying conditions as they will occur in actual floods. There is no control provided which can be used to operate, particularly for the Mississippi River, the effect upon the Mississippi River would in cases be detrimental, and there would be at no time any certainty as to the possible advantage to the Mississippi. Furthermore, with respect to the Tennessee River, the rates of filling and emptying are not such as are necessary for the situation. The rates are prescribed definitely, but in actual operation it should be possible in some cases to discharge these reservoirs more rapidly than provided in order to make available capacity for repeater floods—by that I mean floods which might occur within a rather short interval.

Q. In other words, do I understand you correctly, that even as to the Tennessee, assuming the operation of this same system of detention reservoirs, in your opinion they could not be successfully operated to control successive repeater floods in the Tennessee Valley, is that correct?

A. That is my opinion."

[fol. 1257a] The chart (offered and received in evidence as Defendants' Exhibit 89) shows in the center, that is, on [fol. 1258] small scale, the location of the system of reservoirs as proposed and described in the question given me. Around this small map there are shown profiles of the individual tributaries on which the reservoirs are located, showing the location of each and the elevation. The capacities are also indicated on this drawing.

Examination by the Court:

The chart shows in each case the reservoirs filled, the reservoirs as if filled, and then at intervals of 12 and 18 days after the reservoirs were filled, the elevation of the water in each reservoir. Those are the reservoirs in the system shown on Complainants' Exhibit 352 based upon the assumed method of operation stated in the hypothetical question. It shows the elevation of the water level in each reservoir at the end of 12 days and 18 days, taking into account the stated capacity of the conduits and the average rate of stream flow which is found by the records to prevail in the case of each stream at the reservoir sites; that is, the average stream flow during the flood season or when

floods may be expected, such as to fill the reservoir. This shows the conditions not as to repeated successive floods, but it shows the condition, assuming a flood which had happened, and then the normal stream flow occurring for periods from 6 to 24 days after the complete filling; that is, normal stream flow in high water season coming along after a flood.

The figures on the top line, 6, 12, 18 and 24 give the number of days after the reservoir had been filled, and on the second line, applying to each reservoir, there are figures which represent the percentage of the reservoir capacity which is available at the time stated. For instance, the Painter Creek Reservoir at the end of 18 days has 100 per cent of its capacity available. At the Cove Creek reservoir on the Clinch River at the end of 24 days there is only 33 per cent of the reservoir capacity available. In other words, those figures are percentage figures applying to capacity available at the time stated.

Direct examination continued:

The figures shown and the representation on the diagram indicate to me that the reservoirs would be filled to a substantial extent for a considerable period after they had once become filled. If greater outlet capacity had been provided in cases of local floods, and the reservoirs were all under control, the flood water which would do no damage on the main stream, may be released perhaps from one reservoir at one time, and reservoirs on another tributary at another time, taking the best advantage of conditions as they were at this particular time. In the flood history, and particularly the 1936 flood, a feature of that flood which extended across the eastern United States, was that there was an example of quick repetition of floods. One case I have in mind was this, that on one stream a flood occurred which was the greatest for a period of 47 years, and only six days after that flood, a flood came along which eclipsed all previous records. It is for that reason that I tried to bring out the fact that it is necessary to have a control over the reservoirs so that they can be operated to the best advantage, or operated as the particular occasion demands. I show here, for instance, that under the method of operation hypothesized in the previous question, the detention reservoir at Kiker's Ferry for at least 18 days after it

had first filled, would not have any space available at all. I made these computations and estimates with the aid of two assistants from my office.

“Mr. Fitts: If the Court thinks it would be more helpful in the future in referring to an exhibit like this, we could, of course, put an explanation in writing on the exhibit as to the meaning of these figures.

[fol. 1260] Judge Allen: I should think you would want to for your own protection.

Mr. Fitts: I think it would be advisable, myself.

Judge Allen: The Court considers the exhibit with this explanation admissible.

Mr. R. T. Jackson: We have no objection to it. We want to talk to the witness about it.

Judge Martin: Couldn't the exhibit be clarified a bit?

Mr. Fitts: If we can have the understanding that it is admitted subject to explanation and correction, we will withdraw it and have it amplified.”

(At a later session of the Court, the following occurred:)

“Mr. Fly: We again present defendants' exhibit 89 and at the Court's suggestion the wording has been put in to explain the table on the right, the wording is 'Percentage of storage available in reservoirs at stated intervals of time.' Then other things are listed, and 'Days beginning for storm 6-12-18-24', and then the tables in each column representing the storage space in number of days at the beginning of the storm. I believe that answers the court's inquiry. I offer that in evidence.

Judge Allen: It may be received.”

Referring to Complainants' Exhibit 362 which was produced during the testimony of Mr. Kurtz, I have made a study to determine the comparative amounts of storage for flood control purposes that would be available at the Clinch River site under a dam as outlined on that exhibit on the assumptions that were previously given me and the amount of storage that will be available at Norris Dam under the method of operation that has been testified to in this case.

The chart, (offered and received in evidence as Defendants' Exhibit 90), was prepared under my supervision and direction. In so far as it shows matters of fact, I believe the facts to be correct. In so far as it represents matters

of opinion, or judgment, or estimate, they are my opinions, [fol. 1261] judgments and estimates. On the left hand side of the chart the capacity of Norris reservoir is indicated in diagram-atic form or by a graph for the elevations between 820 and 1060, the elevations being shown on the right hand side of the left diagram and the corresponding capacities in acre feet are shown along the bottom line. The dates are shown as to the expected filling of the reservoir. On the right hand side of the diagram is shown in a similar way the capacity at stated intervals of the Cove Creek reservoir suggested by Mr. Kurtz.

"Judge Allen: Is it your opinion those represent the normal curve of operation levels?

The Witness: It is, your Honor, but it should be explained, of course, that when the floods occur the water stands temporarily above these elevations indicated, and that it is also expected that there might be a slight variation, not exceeding five feet in elevation when conditions might warrant a small departure from this curve. But that does represent my opinion of what, or how the reservoir will be operated.

Mr. R. T. Jackson: Your Honor, I move to strike out the statement of the witness that this represents his opinion as to how the reservoir will be operated, for two reasons:

First. Professor Woodward has already been on the stand and testified he is the man who directs the operation of the reservoirs, and he was unable to fix those levels. The other is that the method of operation will be fixed by rules provided by the Tennessee Valley Authority Board and not by opinions of the witness.

Judge Allen: Well, the Court will withdraw the question. I have changed the question, I will withdraw it.

Mr. R. T. Jackson: I did not object to the question but only to the form of the answer.

Judge Allen: I realize that. I think your objection should be sustained. I will withdraw the question.

Mr. Fitts: We now offer in evidence the chart or comparison between Norris reservoir and Cove Creek reservoir as stated by the witness, as Defendants' Exhibit 90.

Mr. R. T. Jackson: We object to it for the reason it is a graphic representation of something that Professor Woodward said is not fixed and cannot be fixed.

[fol. 1262] Mr. Fitts: He says it can only be fixed approximately.

Mr. R. T. Jackson: He said it cannot, and he is the man that operates it.

Mr. Fitts: He says that this is the general approximation.

Judge Allen: Objection overruled. The Court thinks these objections go to the weight and not to the competency.

Mr. R. T. Jackson: May we have our exception?"

This chart represents the comparative capacity of the Norris reservoir and the Cove Creek reservoir as shown on the right, taking the horizontal line, above which, and between that line and elevation 1041 it is indicated that there is 1,312,000 acre feet available, assuming a maximum outflow of 20,000 cubic feet per second. This volume is equivalent to the total capacity of the Cove Creek reservoir represented on the right, as proposed in the testimony of Mr. Kurtz. In addition to the capacities shown between the horizontal dotted line and the line representing 1041, which might be used up in the case of hypothetical flood resulting from a storm of 11 inches in three days, there is available for flood control purposes, particularly for the sake of repeater floods, and for the sake of Mississippi control floods considered in conjunction with the Tennessee River, a volume below that horizontal line, down to the horizontal line indicated as the elevation expected on December 15th. Up until a little bit later than the first of April there is more storage available in the Norris reservoir than the total amount of storage provided in the dam at Cove Creek proposed by Mr. Kurtz. (The date of January 1 on this chart was subsequently changed by the defendants after the cross-examination of the witness to January 15.)

[fol. 1263] Examination by the Court:

In this chart, which says 1,312,000 acre feet available, the elevation referred to is the dotted line to which the arrow points a little above elevation 1,000, the exact elevation is not stated.

Direct examination continued:

When the reservoir reached that point at elevation 1041, 10 feet over the elevation provided by Mr. Kurtz and 7 feet above the top of the gates at Norris Dam, there would be an

outflow over the gates reaching a maximum of 20,000 cubic feet per second, which is the outflow proposed by Mr. Kurtz' plan.

Mr. Kurtz estimated the reduction in his hypothetical flood of 76% at Knoxville and about 40% at Chattanooga. Those percentages apply to the maximum or crest discharge. In my opinion, the reduction at Knoxville is such as to bring the assumed flood stage down to near the flood stage. At Chattanooga the reduction still leaves the flood of 24 feet above the flood stage. The lack of reduction for Chattanooga as compared with that at Knoxville seems to me to indicate very clearly the necessity for additional storage between the two cities, such as might be provided on the main river.

In my opinion storage reservoirs such as Norris and Hiwassee are necessary to provide a retention of the Hiwassee and Clinch and the Tennessee and the Mississippi flood crests. Our investigations indicate that the Gilbertsville reservoir might be maintained at elevation 355 in the winter previous to a flood and permit the amount of reductions which I have stated. At Pickwick this elevation would be between 410 and 412; at Wheeler about 552 or 553; at Gun-[fol. 1264] tersville it could be at an elevation of 591. These elevations might obtain and still make possible the reductions which I have stated were possible at those dams. My studies show that with these reservoirs maintained at those elevations which I have just stated the reservoirs could be drained down in advance of a flood to obtain additional flood control storage. River reservoirs hold a volume of water at an elevation above the dam substantially above that immediately below the dam. The flood flow at the start of the flood is moderate, and there is a difference in elevation between what we call the headwater, that above the dam, and the tail water, that below the dam, which makes it possible, when the gates are opened, to force out from the reservoir a flow that is substantially greater than the flood flow at the beginning of the flood period. As the flood increases, greater amounts or volumes might be released, and by our computations we find that where it is possible by this means of operation to release water which is in excess of the reservoir in-flow at the start, and then after that as the gates are closed the outflow is reduced and the peak is controlled. Subsequent to the peak, and after the danger is over, the out-

flow again can be increased. The total effect being to even the flood wave and reduce its crest.

The main stream reservoirs above Chattanooga should be maintained at what is called the minimum navigation level during the high water period before an actual flood in order to get the amount of reduction which I have estimated. In my opinion, the filling of the Gilbertsville reservoir to normal pool level between the first and middle of May, and the filling of other main stream reservoirs to normal pool level between April 1 and May 1 would not reduce their effectiveness for flood control. That is because the major floods have passed on that day and the remaining capacity is ample for the control of any flood which might strike there on later dates.

[fol. 1265] The rate of filling which I assumed at Norris and Hiwassee is that Norris reservoir would stand at elevation 955 on December 15 and the filling would increase at a uniform rate with respect to volume reaching an elevation of 1005 on April 15. After that date the flood season would be over and the filling might extend to the top of the spillway if sufficient water is available. Similarly the same operation is assumed at Hiwassee, the elevations being in that case, I believe, from 1415 to 1465, starting at 1415 on December 15 and reaching 1465 on April 15. In my opinion, that character of operation at these reservoirs would not reduce their effectiveness for Tennessee and Mississippi River flood control, for the reason that we have examined and tested out all floods which have occurred within the period of record. The record period on the Tennessee River is about 50 years, and we find no case in which the capacity of Norris reservoir was not able to take care of every critical situation both with respect to the Tennessee and the Mississippi flood controls. We have tested it in all years. I have spent approximately 3 to 3½ years in studying the question of operation which I have assumed in computing these reductions for the flood heights on the Tennessee and Mississippi Rivers.

“Q. Mr. Kimball, if you were instructed to provide a minimum nine foot navigable channel on the main stream of the Tennessee River, and to reduce destructive flood waters in the Tennessee and Mississippi valleys by means of the construction of dams on the Tennessee and its tributaries, what dams would you build?

Mr. R. T. Jackson: I object to the competency of the witness in so far as it calls for what would have to be provided for navigation. The witness has not qualified.

Mr. Fitts: Only the depth, any hydraulic engineer can testify.

[fol. 1266] Mr. R. T. Jackson: That is the theory he goes on.

Judge Allen: Objection overruled. He may answer.

Mr. R. T. Jackson: May we have our exception?

A. I would construct dams that are provided for in the TVA plans at Gilbertsville, Wheeler, Pickwick, Gunter'sville, Chickamauga, Watts Bar, Coulter Shoals, Norris and Hiwassee Dams, and would, if Congress authorized, provide the additional control stated to be desirable in the Unified Report upon the Little Tennessee, the French Broad and Holston Rivers."

I don't know of any other type of dam that could accomplish all of these purposes.

[fol. 1267] Cross-examination:

I didn't name any dams on the Holston and French Broad. I said that I would include some control on those rivers. When I spoke of control on the Holston and French Broad, I meant control through the construction of dams and reservoirs. I had in mind one on each.

On the chart, Defendants' Exhibit 90, entitled "Comparison between Norris Reservoir and Cove Creek Reservoir suggested by Ford Kurtz", I show elevation 965 or somewhat higher for Norris reservoir on or about January 17. I think it might be raised to 967. I think that would be a fair approximation. I notice that this chart where it states January 1st, that should have been January 15th. If that is true, the elevation on January 17th would be very nearly the same as that on January 15th. That is somewhere around 965 or somewhat higher. I can not state what the elevation of Norris Reservoir was on January 17, 1937.

"Q. Don't you know it to be a fact that it was 1031?

A. January of this year? We had during the month the highest rainfall that is on record over the Clinch basin, and, necessarily, the reservoir was being filled and used for the control of floods below.

Q. Now, you have made your explanation, will you answer my question? On January 17th of this year was the Norris reservoir at elevation approximately 1031?

A. It was at elevation 1031 until some date, I cannot testify as to the actual date."

Norris reservoir reaches elevation 1010 on Defendants' Exhibit 90 somewhat earlier than April 30. Of course, what it would reach would depend upon the amount of stream flow. Held down to 1005 on April 15, there is very much question as to what date it could reach 1010. That is wholly [fol. 1268] governed by the amount of stream flow in the Clinch River. As to whether the curve on this exhibit does not mean anything, the curve which is shown on this exhibit does not indicate the stream flow. It indicates the elevations at which it is assumed, under ordinary conditions, the Norris reservoir might reach on the dates stated. The actual elevation would depend upon conditions. Whenever there is a short flood, the water level rises fast. When there is a smaller flow, it might not reach the elevations indicated. It is true that on my chart I do show that it does not reach elevation 1010 until about April 30. Whether or not it is a fact that in 1937 the Norris reservoir was never below 1010 from January 17 on until the end of the low water season, I can't state when it dropped below 1010. I don't recollect whether it did not drop below 1010 until after June. That may be true. As to whether when I gave my testimony I had no recollection, if it be the fact, and no knowledge that Norris reservoir was in fact maintained at or above 1010 from January 17 on in 1937, at the time I gave my testimony I did not speak of any actual elevations in the past. I did not say that this curve hasn't anything to do with the realities of the situation. With respect to the statement of Dr. Morgan in Complainants' Exhibit 116, page 375, that he would let Norris go up to about 1010 in January, I remember he made some statement which was afterwards qualified.

On Defendants' Exhibit 90 I also show 1,312,000 acre feet between the dotted line and elevation 1041. I happened to select 1041 because that is the elevation at which 20,000 cubic feet per second will flow over the top of the gates if they are closed. From elevation 1041 down to the dotted line there is 1,312,000 acre feet. We showed that storing that

volume of water between those elevations would result in an outflow varying from zero up to the maximum which Mr. [fol. 1269] Kurtz provides in his plan. The purpose of the 1041 was to give the maximum of flow corresponding to Mr. Kurtz' outflow. Except for the purpose of trying to get a figure which was the same as the one shown on Mr. Kurtz' reservoir, I might as well have taken 1040 or 1050. I might have taken 830. If I had taken 830, I would not have gotten any storage in acre feet. As to there being some limit in the manipulation of the figures, I did not understand that you stated that 1,312,000 was to be provided. As to whether, in connection with my elevation 1041 on Defendants' Exhibit 90, I do not know that we spilled Norris reservoir in the Spring of 1937 at elevation 1031 because it was running over the highways up there at that elevation, I didn't understand what you meant by spilling. All water was withheld at that time.

"Q. Didn't you start discharging from Norris reservoir at elevation 1031 or thereabout because you were flooding the highways between LaFollette and Cumberland Gap?

A. We started to release after the danger below was over.

Q. I just want to get it straight. You want to testify that you did not spill out of Norris Dam at elevation 1031 or a little better last Spring because at that elevation you were flooding the road between LaFollette and Cumberland Gap and flooding everything up around Norris reservoir?

A. Well, it is—

Judge Allen: Answer the question, please, and make your explanation afterwards.

A. I hardly think that is exactly true. We released just as soon as possible."

I would hardly say that the following telegram sent to Colonel Powell in response to his request refreshes my recollection as to release of water at Norris at around elevation 1031 because it was flooding highways and other things:

[fol. 1270] "Release at Wheeler had already been reduced before receipt of your telegram on February 6th and is being held to the minimum practicable. Norris and Wheeler reservoirs were filled until great damage to highways, rail-

ways and towns was imminent, in order to give maximum reduction of flood crest at Paducah. It is necessary now to release water as rapidly as safe so as to be able to handle subsequent flood flows. We estimate water from Wheeler reaches Paducah in about four days."

We would have released it regardless of the flood.

"Judge Gore: It would occur to me that it would be sufficient to answer the question and say whether or not the water was at 1031 and did flood the highways around there.

Mr. Fly: If your Honor please, we concede that the highway floods at that level.

Judge Gore: All right.

Mr. Fly: But I want to make clear my point, now you have got into this. The witness is not denying that the highway was flooded, but the witness is asserting that the flooding of the highway is not his major problem, and that is the very testimony he has given twice.

Judge Allen: Mr. Kimball, I suggest that you listen very carefully to the questions and answer them and then you are entitled to make your explanation."

In Defendants' Exhibit 90 I show a comparison between Norris and Mr. Kurtz' flood control reservoir at Cove Creek, which is substantially the same place. I understood that Mr. Kurtz was providing some 19 headwater reservoirs on tributaries of the Tennessee River. I also remember that he testified that his reservoirs would control 78% of the drainage area above Chattanooga, but I do not remember that he stated that this was in comparison to some 14% by Norris. I know myself, however, that Norris controls only about 14% of the drainage area above Chattanooga.

Referring to the right-hand diagram on Defendants' Exhibit 90 where it shows a discharge of 20,000 cubic feet per second, that is intended to mean when the reservoir is filled. It is intended to mean that that is the outflow that is provided for the reservoir, both for filling and emptying. It was not my understanding that Mr. Kurtz testified that the controlling outflow during filling would be 20,000 second feet and that after the reservoir was filled the discharge would vary in accordance with the conditions for a particular flood, being arranged so as to empty the

reservoir as soon as practicable to be ready for another flood.

"Q. Mr. Kimball, in giving your testimony, did you understand that the discharge from the system of reservoirs outlined by Mr. Kurtz after the flood would be at the same rate as the rate of flow which had been stated by Mr. Kurtz?

A. I did. He stated that repeatedly.

Mr. R. T. Jackson: Well, I move to strike out the last sentence. The record shows for itself.

Judge Allen: That may stand.

By Mr. R. T. Jackson:

Q. All I want to know is that your testimony is based on that. Now, if it be a fact, Mr. Kimball, that Mr. Kurtz' system of reservoirs was designed so that the discharge did not vary in accordance with the conditions prevailing, after the flood, your conclusions which you have stated here in that respect, would be incorrect, would they?

Mr. Fly: I object to that question being based upon an assumption not borne out by the record. I would like to be heard.

Judge Allen: The Court sustains the objection to the question on the ground that on page 2064 (of the stenographic record) Mr. Kurtz gave the rate of release when the reservoir was filling at Cove Creek, of 20,000 feet per second.

Mr. R. T. Jackson: Yes. We take opportunity to point out to the Court and show it has no relation whatever to the rate of release for the reservoir after it is filled, and this question is directed to the latter point.

Mr. Fly: He says it is the same. Can you point out where it is different?

Mr. R. T. Jackson: The same point this witness tried to make on Exhibit 79.

Judge Allen: The objection is sustained. The Court will say it is not going in general to go into the record. The [fol. 1271a] objection is sustained. You may have your exception.

By Mr. R. T. Jackson:

Q. Mr. Kimball, I direct your attention to this statement of Mr. Kurtz on page 2077 of the (stenographic) transcript:

'During the emptying program, the opening of the lowest reservoir of each of these principal tributary groups would be maintained at a constant and fixed discharge, and that would be such as to keep the discharge below the reservoir [fol. 1272] and all the way down as nearly as possible at banks full stage. The upper reservoirs on each tributary would have their discharge varied within a considerable range, so as to suit conditions obtaining for any particular flood.'

That, I call your attention, is dealing with the emptying program. I now ask you whether, if you had made this assumption which I have quoted from Mr. Kurtz' testimony, your testimony here this afternoon, as shown on Exhibit 89, about that exhibit, would not be incorrect.

A. I am confused about this matter in this testimony quoted. He states that the discharge will be maintained at the constant and fixed rate, then he states the upper reservoirs on each tributary would have their discharge varied within a considerable range so as to suit conditions obtaining for any flood. I am confused as to the meaning of that in view of the subsequent testimony in which he appeared to make it very clear to me that he had no provision for any alteration whatever."

I think I understand the question whether or not my answer with reference to Defendants' Exhibit 89 would be incorrect assuming merely the testimony read to me in the last question. I will say that my calculations would still stand for this reason, taking this clause quoted alone—it appears that there might be in the upper reservoirs a larger range of discharge but that the lower reservoirs would still maintain the stated discharge. The effect of that would be to retain within each tributary the same amount of storage which I assumed was true. It might vary between the reservoirs, but would still be there, and the system I consider would still be defective in that respect. Bank-full stage, immediately below Norris Dam, is in the neighborhood of 30 or 40 thousand second feet. If you take Norris as the lowest reservoir on that river and release water at the rate of bank-full stage, that would be 43,000 second feet with that figure for bank-full stage. The figures given in Defendants' Exhibit 89 show the results that we would get from releas-

ing 20,000 second feet and the figures were taken with considerable care from the record of Mr. Kurtz' testimony in [fol. 1273] which he stated the discharge was 20,000 second feet for Cove Creek. They were taken from figures read to me by Mr. Fitts. I cannot recall whether Mr. Fitts read the fact that those figures were for rates of release when the reservoirs were filling instead of emptying. I understood they were filling and that is the basis of my answer. That is the basis of every figure and all the information that I showed with reference to the emptying of the reservoirs on Defendants' Exhibit 89; that is, I take the same rate of discharge as the rate stated for filling during the flood.

"Q. And in no case does that reflect any variation for upstream tributaries, and in no case does it represent banks-full discharge for the lowest down reservoirs?

A. I understood that the discharge stated was the discharge to be used regardless of whether it was banks-full stage.

Mr. R. T. Jackson: I move to strike out that answer, and move that the witness be required to answer.

Judge Allen: Will you answer the question and make your explanation, please?

A. It reflects no variation. I do not see any relation between that figure and banks-full stage.

Q. Well, if any one of your reservoirs contained on Exhibit 89 reflect a rate of discharge corresponding with bank-full stage, please tell us which it is.

A. Those discharges have nothing to do with bank-full stage.

Mr. R. T. Jackson: I move to strike that out and ask for an answer to my question.

Judge Allen: Answer the question and then give your explanation.

The Witness: If your Honor please, I don't understand that question requires a yes or no answer.

Judge Allen: If you can't answer the question you don't have to.

[fol. 1274] Mr. R. T. Jackson: I move to strike out his testimony.

Judge Allen: The motion is overruled."

I am to a very limited extent familiar with the plans of the Reclamation Bureau for constructing Norris reservoir.

I am not familiar with the fact they recommended a flood storage there of 1,255,000 feet in comparison with Mr. Kurtz' 1,312,000 acre feet. I don't recall just what was recommended there. I am not familiar with the fact that the Bureau of Reclamation reported to the TVA that a pure flood control project of that size at Norris would cost only \$7,150,000.

I cannot say at what elevation Norris reservoir and Hiwassee reservoir would have to be on January 1, February 1, March 1, April 1 and May 1 in order to provide the TVA unified system with 660,000 kilowatts of firm capacity 24 hours a day and 5,780,000,000 kilowatts of energy annually in a dry year like 1925. Our flood control studies were not based upon power requirements.

"By Mr. R. T. Jackson:

Q. Mr. Kimball, if it be true that in order to provide that amount of firm capacity and the annual firm energy output which I have previously stated, through the TVA Unified System in a dry year such as 1925, it will be necessary to fill Hiwassee and Norris at somewhat above their normal pool levels as early as March in each year, if not before, will not there be less storage capacity available after March 1st for flood control than you have assumed in the answers and testimony you have given here today?

A. May I state the question as I understand it, to see if it corresponds with your question?

Q. Well—

Judge Allen: Yes, you may.

A. As I understand your question, as it refers to Norris, you refer to normal pool as at elevation 1020?

Q. 1020.

[fol. 1275] A. And you refer to the elevation that I have stated on March 1st as being about 990?

Q. Oh no, no. I refer to the elevation being 1020 or somewhat above as early as March 1st or earlier, perhaps February 1st.

A. As I understood your question, you stated that the elevation would be at 1020 on March 1st?

Q. March 1st or earlier.

A. Rather than at about 990, assumed by the chart?

Q. That is right.

A. And you asked whether there would be as much flood storage on March 1st as the chart—

Q. No, as you have assumed in making your answers and giving your testimony here today.

A. Well, I understand that to be an equivalent statement, I would say that it is clear that if the water level were at 1020 instead of being as indicated on this chart, that there would not be the space available between those points.

Judge Allen: What do you understand to be normal pool level?

The Witness: I don't understand that there is any such thing as normal pool level."

I produced a photograph which was introduced in evidence as Defendants' Exhibit 79 in which I showed a threatened flooding of the Tennessee Electric Power Company building. I am not sufficiently familiar with the operations of The Tennessee Electric Power Company to know whether that company, when it found that the TVA Unified Plan would not protect Chattanooga, readjusted its operating plans so as to be able to give service to those areas which are flooded out during high floods.

It is desirable to protect against large floods if you have flood protection. The system of flood protection against moderate and minor floods is not necessarily a very disadvantageous thing. It is advantageous as far as it goes. Whether or not a system of that kind is really just a human [fol. 1276] death trap depends upon conditions. It is a human death trap in case of leveed areas in which the levees may be overtopped.

I testified in the Ashwander case and was asked the following questions and made the following answers:

"Q. In other words, you said that, without being supplemented, instead of being helpful they amount to a menace to the community?

A. By 'menace' I would like to quote from a work of Alvord & Burdick, a book entitled 'Relief from Floods'. It is stated here:

'When works are concerned and intended to protect a large population, a half-way measure is nothing less than a death trap. Anything less than to adequately protect a place of human habitation, is worse than no protection at

all, for it creates a false sense of security and multiplies the consequences of failure'.

Q. Does that represent your own opinion?

A. It does."

I would like to explain that. The Alvord & Burdick who wrote this book referred to were the engineers employed by the City of Columbus, Ohio, to devise a plan for the protection of that city. They devised a system of reservoirs which seemed to be very expensive to the people concerned, those who had to pay for it, and they required the engineers to develop a plan of smaller proportions. The plan which was developed involved the construction of levees and protection walls about the city of Columbus at a height which was inadequate to provide for what Alvord & Burdick considered was a flood that would reasonably be expected. The result was that it left the city of Columbus in a basin, and the greater floods coming would go over the rim of the basin and flood the city, and then the basin becoming a death trap, as referred to in the quotation. One effect is that if you simply grant minor relief it prolongs the interval between flood visitations and the people become careless and are more likely to be entrapped. It prolongs the intervals, but that is not the essential thing in all cases.

Examination by the Court:

That book discussed the Columbus situation but I cannot say at this time what the context was.

Cross-examination continued:

I read it in the Ashwander case as having a bearing upon flood protection in the Tennessee Valley.

"Judge Allen: The Court has considered the question of recess, and in making its decision has borne in mind not only the necessity of disrupting any more than possible the work in three courts in this circuit, but also has borne in mind that various important phases of this case at least have been litigated and re-litigated in other courts, so that, as previously stated, we feel that there is very little element of surprise in this case.

The Court will adjourn at 4:00 o'clock on Thursday, December 23rd, and it will reconvene at the usual time on

Monday, January 3rd. If it is necessary to take further testimony at that time, the Court will hear such testimony as is necessary. The Court will expect counsel to prepare and be ready to submit findings of fact and proposed conclusions of law when the testimony is concluded, and the Court will proceed immediately to the argument of the case when the testimony is concluded.

We think that we should make this announcement to you in order that you could use the intervening time, the three days that you have, preparing to submit the findings of fact and perhaps conclusions of the law to the Court in accordance with the Court's ruling.

Mr. R. T. Jackson: I should like to crave the Court's indulgence for at least one day after the close of testimony, because we will be working continuously if we have any rebuttal, and I should dislike to have to undertake the oral argument of the case completely exhausted.

Judge Allen: I think that the Court perhaps will hear your application at that time, Mr. Jackson, but we want to make it perfectly plain to you that this Court is going to sit until this case is concluded. We are not going to go away [fol. 1278] from here until this case is concluded.

Mr. R. T. Jackson: I just wanted to get in a plea in the name of humanity.

Judge Allen: In the name of humanity the Court has conceded to you ten days between December 23rd and January 3rd, or more than that.

Mr. R. T. Jackson: We appreciate that, but if we should be exhausted again—

Judge Allen: We will recess now."

The chart (offered and received in evidence as Complainants' Exhibit 912) was my Exhibit 29 in the Ashwander case and shows a cross section of Norris Dam and reservoir in the figure on the right-hand side of the exhibit. The storage space on the lower right hand corner is marked with the legend "Dead Storage". Above that "Dead Storage" is a line which is about 1020. It is marked "1,500,000 acre feet available at times for flood control". I have shown above that another section, 1,400,000 acre feet available for flood control. That is the upper bracket and is above 1034 up to the top of the dam above the gates. I cannot see just how high that goes. There is no elevation marked. I can see that it goes above the top of the gates—

it is impossible to say from my drawing. In the figure on the lower left-hand corner of this exhibit (Complainants' Exhibit 912) I have, at the back of the lower dam, shown a large part of the impoundage space marked "Dead Storage". I think that above that there is a level marked "Maximum level for flood control", over the shaded area. There are some designations within the shaded area. Between the line marking "Dead Storage" and the line marking "Maximum storage for flood control", I have indicated in brackets on the left-hand side the amount available for flood control. The line marking Dead Storage cutting across the gates shown in the drawing is somewhat more than half-way up the gates. In connection with that exhibit in the Ashwander case I was asked the following question and [fol. 1279] made the following answer:

"Q. Well now, do you mean that that is all of Norris Dam that is available for flood control, or is this other also available?"

A. This other will also be available when the reservoir has been depleted, for other reasons, such as replenishing for low water flow of the river, it is generally the case, that in a storage reservoir it will be depleted during the fall so as to have a volume at flood time for incidental flood storage."

Defendants' Exhibit 67 is rainfall and run-off data, and I show the drainage area of 21,400 square miles in the upper part above Chattanooga and I show the Clinch River drainage area as 4,400 square miles. As a matter of fact there is only 2,950 square miles of that drainage area in any way controlled by Norris Dam. The Hiwassee shows 2,660 square miles but there is only 977 square miles of that drainage area affected by the dam. The figures for rainfall are typical for that, but that would be unimpeded so far as these two storage reservoirs are concerned. I spoke of possible reservoirs on the Holston River and the French Broad River. The extent to which they would affect this drainage area would depend upon their location which would be at some place above the mouth, it not necessarily substantially above.

Defendants' Exhibit 71 shows the outstanding storms, occurrence and paths of great rainfall. Every one of the storms that I show on that exhibit are travelling from the

southwest to the northeast. My failure to show the storm of 1926-27 was not in any way influenced by the fact that that storm travelled from the northeast to the southwest. There is no connection with that. I don't recall that that storm travelled in such an abnormal way. If you have got a storm travelling from the southwest to the northeast, it is true that the rainfall first concentrates on the lower Tennessee basin, but in the general rains the rainfall very often is still quite heavy on the first section touched by the time the heavily rainfall reaches the upper. Whether or not the concentration of rainfall will occur earlier in the lower basin where the storm first strikes than in the headwaters where it strikes much later, would depend on the duration of the storm. In a very long storm, the concentration will be due to the run-off from all parts of the drainage area. The first run-off comes from the lower part where the storm first comes.

“Q. And to the extent that you retard that run-off in the lower basin where the storm first strikes and the run-off first concentrates, you hold it to meet the run-off from the upper basin, do you not?

A. You are speaking of a—you are supposing a case of operation?

Q. I am just saying, to the extent that you retard the initial concentration of run-off in the lower basin, do you not hold it so that the run-off from the upper basin may be superimposed upon it?

A. Well, that would depend upon conditions ordinarily under the operation. At the lower end of the Tennessee basin you would probably discharge the early flow as quickly as possible before the crest on the main stream—by the main stream I mean the Ohio—reached the Tennessee.

Q. I am just talking about the Tennessee now, one problem at a time. I want to get the water out of that river. Now, Mr. Kimball, suppose you have a storm traveling up the Tennessee Valley as you have shown all your storms do, and there is, therefore, a concentration of early run-off in the lower Tennessee basin, if under those conditions you were to dump reservoirs upstream in advance of the oncoming storm, would you not merely dump that storage onto the flood waters in the lower Tennessee?

A. Well, the water released from the upper reservoirs would flow down to the lower portions.

Q. Yes, and it would be added to the flood run-off that was already concentrating in the lower Tennessee River, would it not?

A. Except that corresponding release would be made in the lower region so there would not be that build-up that you suggest.

Q. That is, you would not advise holding any of the lower Tennessee from running off as it would in a state of nature?

A. The operation would be according to the conditions in the individual case. Ordinarily I would say that the operation would tend to release from the lower reservoirs very promptly."

[fol. 1281] Defendants' Exhibit 82 is presented to show what we assume could have been the result of various reservoirs on flood heights at Chattanooga by the operations during the actual floods indicated. On that exhibit I show only the floods of 1926, 1936, and 1917. I have omitted the two or three largest floods that ever occurred on the Tennessee River, but it was impossible to make any computations on the early floods for the reason that we have no measurements of the flow, particularly in the tributaries. The gentleman who took the pictures all over Chattanooga showing the height of the 1867 flood could not have made those computations because he is not a hydraulic engineer. I do not think that the Army Engineers in House Document 328 set out figures for the flood of 1867.

I think I have seen Plate XIX (offered and received in evidence as Complainants' Exhibit 913) from Volume 2 of House Document 328, but I am not sure. It indicates flows for various floods including the flood of 1867 on the Tennessee River from Knoxville down to the mouth of the river. That includes Chattanooga, but does not give any basis for such computations as are indicated on Defendants' Exhibit 82. It shows nothing respecting the tributary contributions to the Tennessee River. That information is necessary for the computation of control. I did not either show on Defendants' Exhibit 82 what reduction, if any, would be effected by these various reservoirs with a super-flood. I attempted to confine these computations to actual occurrences. Whether or not when you are designing anything for flood protection you simply base your design upon some historical fact that has happened in the past, and if the only one for which you happen to have data is a small

one, you base it on the small one, would depend on the nature of the problem. The nature of the problem of flood control is usually to protect against damage from a large flood. I would like to explain that if we have cities to be protected and those cities have a levee system, it is necessary to estimate the largest flood which may be reasonably expected, [fol. 1282] and compute the degree of control which is necessary to bring such a flood down to the capacity of the local system. That situation does not exist in the Tennessee Valley. There are no cities or towns, so far as I know, that have any levees on them, and our problem here is to make such reductions in flood heights and in flood frequencies as we are able to do with the projects authorized by Congress.

I think I am largely responsible for the following statement on page 16 of the Unified Report of the TVA to Congress, (Complainants' Exhibit 328):

"An appreciation of the probable magnitude and frequency of future floods on the Tennessee River is generally lacking because the largest floods in the past occurred over 50 years ago. The Tennessee River basin, because of its location with respect to the line of travel of storms of intense rainfall and because of the characteristics of its drainage area and river system, is likely to be visited by extreme floods. Since Tennessee River records have been kept only for a limited period, estimates of probable future floods must take into account flood data relating to all river systems in this portion of the country as well as all the characteristics of the river system and of the Tennessee Valley.

"Consideration of these data leads to the conclusion that in the upper basin a flood should be anticipated 50 per cent greater than the great flood of 1867, which at Chattanooga had a maximum discharge of about 430,000 cubic feet per second."

I still agree with that statement. It is not true that among smaller floods of record that have occurred, I have selected on Defendants' Exhibit 82 the three floods when it happened that the largest contribution was made by the Clinch and Hiwassee Rivers. It is not definitely known that in the flood of 1867 the principal contribution was made by the Holston and French Broad. I told you that Norris reservoir controlled 14 per cent of the drainage area about Chattanooga. The Hiwassee controls about 4 or 5 per cent. Together they

would be about 18 per cent. It would make a lot of difference whether I selected floods in which the major contribution came from the Clinch and Hiwassee. Our studies indicate [fol. 1283] that these two streams have been among the larger contributors. I have not the data here to tell what percentage of the total the Clinch and Hiwassee contributed to the three floods I selected. That data was used in the computation.

“Q. Very much more than the proportionate drainage area, wasn't it?

A. That is the usual case.

Q. Well, was it here?

A. I am not sure about these three specific cases.”

Assuming a flood of the character I described in the Unified Report (Complainants' Exhibit 328), that is, 50 per cent greater than the maximum flood of 1867, brought about by rainfall spread uniformly over the drainage area above Chattanooga, we have made some studies as to the amount of the reduction in the flood heights at Chattanooga which would be brought about by the Norris and Hiwassee reservoirs. They were approximate, however, and I have none of those figures here. They were certainly substantial, I can not say how small. I should say more than three feet in stage, but I can not be positive without the figures here. I did not include that on Defendants' Exhibit 82 because we have no data on the tributary flows in the 1867 flood. As I understood, the project flood referred to was 50 per cent in volume above the 1867 flood, so in referring to that project flood I am assuming that it was 50 per cent greater, and you would naturally take your tributary flow and add 50 per cent to that, and I have not that data.

If you had a flood 50 to 70 per cent greater than the 1867 flood without any control on the upper river, I do not think the gauge at Chattanooga would be less than somewhere around 70 or 73. I don't think it would be any less than 73.

“Q. Now, when the gauge is at 73 at Chattanooga, what will be the condition at Chickamauga Reservoir and Dam? [fol. 1284] A. Well, there will be extreme flood flow passing through it.

Q. Well, you know that the flood of that height at Chattanooga, which is even further down stream, would be seven feet over the gates of Chickamauga, don't you?

A. Well, I don't know to what extent that is true.

Q. Do you know what zero is on the gauge at Chattanooga?

A. It is about elevation 621.

Q. And if you had a 73 foot stage, you would have an elevation at Chattanooga of 694?

A. That is correct.

Q. And what is the top of the gates at Chickamauga; 685, isn't it?

A. Yes, I believe that is correct.

Q. Now, under those conditions on a large flood, don't you know it to be a fact that, for instance, Chickamauga reservoir would be absolutely useless for the protection of Chattanooga?

A. With such a flood the depth in Chickamauga reservoir would be reduced below that assumed, because of the reduction from the tributary reservoirs, Norris and Hiwassee, or any others which might have been authorized by Congress at the time such flood occurred."

It is not true that assuming you had a gauge height at Chattanooga of 73 feet, Chickamauga would be utterly valueless. Under those conditions Chickamauga reservoir would raise the flood heights above the dam and would bring in a larger storage above the dam than would otherwise be the case with the storage above Chattanooga. That storage would have a favorable effect to some extent upon the flood, and as the flood subsided the reservoir could retain a portion of the total flood volume. I mean that Chickamauga basin would increase the flood storage or valley storage in the case of a high flood, so that would tend to bring down the flood heights even though Chickamauga were flooded out. The storage would undoubtedly be rather swift if Chickamauga was running over the top of the dam by a depth of 7 feet.

[fol. 1285] I made the following statement in an address before a section of engineers, the senior discussion group, Knoxville, Tennessee, January, 1936:

"I would just like to show you for a minute if you can see it, a diagram which shows the past floods on the Tennessee River—taking up diagram—Chattanooga is at this point, and this is Hales Bar immediately below. The upper line represents the 1867 flood. The distinct drop which occurred just below Chattanooga is due to the narrow gorge through which the river runs within the Hales Bar pool. Just above Chattanooga is represented the Chickamauga

dam, with the proposed water level being just like that. A minute's inspection shows that that dam alone would be of no value to Chattanooga, with the repetition of the 1867 flood."

I tried to explain my ideas as best I could. I tried to make a truthful statement about it. If I may, I would like to continue this:

"The function of the tributary dams is to reduce floods from some stage up here—pointing to '67 flood line—down to something more like the '26 flood, so that it will be within the capacity of those river projects."

The purpose of that was to show the mutual relation of the tributary projects and the main stream dams in the lowering of floods. The main river projects contribute far more on the moderate floods than they do on the very extreme floods, and the tributary basins have the purpose, as indicated, to bring down the extreme floods to the size of moderate floods, and thereby make the main river projects more effective.

I would like to make a further statement on my previous testimony that I was still in accord with the view that I expressed in the Ashwander case by reading from Alvord & Burdick to the effect that real flood protection should take care of large floods, and not through creating impressions of false security, create man-traps. In looking over the testimony on that I found that it was referring specifically to [fol. 1286] the suggested levee construction at Chattanooga, certain levee systems had been proposed. Their levees in that plan did not seem to me to be adequate and I felt that the floods which might come without reservoir control above would go over these levees, wash them out, and suddenly precipitate an extreme volume of flood water on to the city, which with the levee around it would in such case be a death trap.

Referring to Defendants' Exhibit 86 which is a Gilbertsville chart, I testified that the effect of valley storage is to reduce the peak on that particular stream, but to prolong the flow. That is true in this case about the discharge of the Mississippi and Ohio Rivers.

Defendants' Exhibit 84 is a table entitled "Date of flood peaks at Johnsonville on the Tennessee River, Paducah on the Ohio River and Cairo on the Mississippi River for past

floods exceeding 50 feet at Cairo." Johnsonville on the Tennessee River is located about at the mouth of the Duck River. In time of flood it is about a day and a half or two days from Paducah. I would think a day and a half is very close. Referring to Defendants' Exhibit 84, it is, of course, true that one would have to make the time allowance of at least a day and a half in order to correlate the Johnsonville peaks with the Ohio peaks at Paducah. In 1882 the Johnsonville peak preceded the Ohio River peak at Paducah by 24 days as shown by the exhibit, $22\frac{1}{2}$ days to make the time factor correction. In 1883 the Johnsonville peak preceded it by 2 days on the exhibit, or something less than half a day after making the time correction. I would say that in 1886 it hit it on the nose. It depends on whether you take the 15th or the 16th. If you take the 16th for the peak at Johnsonville it got to Paducah a half day behind the Ohio peak. In 1903 there was 4 or 5 days' difference. In 1937 there was 8 days difference, without any correction, and just taking the figures on the exhibit. This shows the relation between the [fol. 1287] Tennessee peak at Paducah and the Ohio peak at Cairo as constantly varying. In the 1897 flood, which was not mentioned, there was close agreement. That is the flood which created the big damage on the lower river. There is a variation, but on the average there is a distinct difference in dates on the Tennessee River. That is not a practical coincidence on the average years.

With respect to Defendants' Exhibit 85, on the left-hand side in the upper part, I have shown in the first column the dates; the second, the Ohio stage at Paducah; the third, what I call inflow into the Tennessee River; fourth, the actual flow; and fifth, the difference in cubic feet per second. That fifth column represents, according to my testimony, the extent to which the natural flow of the stream in the Tennessee was reduced by valley storage. I show that that valley storage during the period shown as the peak inflow on the Tennessee River ranges from 111,000 second feet on January 19th to a low of 106,000 second feet on February 25th, the highest being 119,000 second feet on the 21st. In those days each one was over 100,000 second feet. During that period the outflow of the Tennessee was quite substantially reduced by valley storage. The Gilbertsville reservoir reach, I might say, is about 184 miles in length, and in that section of the river there is more valley storage than at any point above.

I have not followed the years to determine whether or not it is a fact that if in 1937 the Ohio peak at Paducah had followed the Tennessee River peak as closely as it did in 1883, 1884, 1886, 1897, 1903, 1907, 1912, 1922, 1927, 1929, 1933 and 1936, this valley storage would have decreased the peak on the Ohio at Paducah, and consequently at Cairo; but I do not see how it is possible to combine that outflow with these other cases, because that upsets the whole thing. It upsets the Ohio River flow. I can't say specifically for the dates [fol. 1288] mentioned whether if I make the correction for the time of a day and a half to two days on the Johnsonville peak, shown on Defendants' Exhibit 84, and compare that with the Ohio River peak at Paducah, I will find for the years mentioned that there would have been a practical coincidence of the Tennessee River peak at the mouth at Paducah and the Ohio River peak at Paducah, because I did not notice them at the time. But I was fully aware that there were some cases where there was synchronization. Taking for instance February 23 and February 25, 1883, it is true that if you allow a day and a half to two days, it is practically coincident. At the times when there is a practical coincidence between the Tennessee peak at its mouth and the Ohio River peak at Paducah, the valley storage, which took up 119,000 second feet from the peak of the Tennessee, would be favorable to the Ohio River flow and reduce the peak in the Ohio at the mouth of the Tennessee and consequently at Cairo.

On the first flood that I show on Defendants' Exhibit 84, I show that the Tennessee River peak preceded the Ohio River peak at Paducah by 22 days and a half in the 1882 flood. I do not know whether under those conditions, if you did not interfere with the outflow from the Tennessee, it would have swept out all of the water that I show held in valley storage to reduce the peak of the Tennessee and subsequently released down to the safety level of the Tennessee on Defendants' Exhibit 85. To determine whether the Tennessee would have run out before the Ohio peak came along in the flood of 1882, you would have to look at the hydrographs of the 1882 flood. If the operation was the same as I have shown on Defendants' Exhibit 85, it is not necessarily true that all of the water of the Tennessee set out on the left-hand side and all that set out on the right-hand lower side would have run out and gone down the river before the peak of the Ohio ever came at Paducah. That depends on

how long the crest remained in the Tennessee. It may have been a very prolonged crest. I do not know whether it [fol. 1289] would have to have been a more prolonged crest than I show in Defendants' Exhibit 85. It would have to have been a more prolonged crest than the 1937 flood. I don't remember that I gave any testimony that the flood crests on the Tennessee are more than 22½ days long. The crests on the Tennessee vary from flood to flood. I can not give a general answer to the question, dealing with a flood where the time differential was 22½ days and I could not tell if the Tennessee would empty before the Ohio flood because the crest might be too long on the Tennessee, whether the flood crests on the Tennessee prevail for longer than 22½ days.

Examination by the Court:

I would have to look over a considerable number of years to give any general statement as to how they do vary in length.

Cross-examination continued:

In 1884 there was a very prolonged high stage in the lower river, more than in some others. There is no definite rule. The high stage prevailed on the lower Tennessee River in 1884 about 25 days. I have not the figure for flood stage here. I was just taking as high stage what appeared to be, with general reference to the hydrographs, an abnormally high stage. I think that the Tennessee River at its mouth has to get 240,000 to 260,000 second feet to reach the flood stage. It is not necessarily true that if the crests of the Tennessee floods may last 25 or 30 days, any one who is undertaking to provide flood protection by storage would have to store over that period in anticipation of this unfavorable condition. Whether they would if they wanted to guard against floods would depend upon the critical period below. If we were not examining historical floods, we would not know in advance whether the flood is going to be 30 days [fol. 1290] long or just what it is going to be; but on the lower Tennessee the prediction system of the Mississippi River Commission enables us to predict for several days in advance.

I do not think that it is true to say that I took for Defendants' Exhibit 85 practically the only incident, if not

the only incident, in the whole history of floods at Cairo, when the valley storage on the Tennessee River did not operate to reduce the flood peak at the mouth and the flood flow on the Ohio and consequently at Cairo. There are two instances on Defendants' Exhibit 84 where the result would have been different, that is in 1912 and 1913. Those were years of very high Ohio River floods. For 1912 it is April 6th, and when you correct that, it becomes some time around April 8th, and the peak at Paducah is between the 8th and the 11th. The peak at Paducah continued about 3 days after the corresponding time. In 1913 the peak at Paducah was reached 7 days after the peak allowing for travel time. Those are just two I noticed.

In the third column on Defendants' Exhibit 85, I show inflow and I stated that the first column represents the flow as if it were in a pipe-line—that is, if the velocity were speeded up sufficiently to carry the entire flow. It is approximately correct to assume that if the total flow into the Gilbertsville pool had been in a pipeline from the period shown on the exhibit, January 16th to February 9th, inclusive, it would have been discharging at the lower end in the quantity shown in the column on the exhibit headed "Inflow". I assumed no definite length of pipeline. I am assuming the river flow, what you might call a flow in a pipeline such as might be in a water-works system, for instance, so that the entire water was carried in a pipeline instead of an open river. In answer to the question whether [fol. 1291] I assumed the length to be the river miles between Pickwick and Gilbertsville or a straight line between the two points, I don't quite see that the length of the pipeline enters into it. The idea is that the flow is as fast as it is being contributed and it is carried out immediately. I used the illustration of the pipeline in an attempt to convey the idea that the water would not spread out but would be carried immediately through the river.

"Q. Well now, will you answer my question, Mr. Kimball?

A. I made no definite assumption as to the length."

I should say that it would not make a very appreciable difference in my results. The river, even if it were a pipeline, whether it had any appreciable amount of valley storage or not, would have to follow its winding curve. I did

not make any allowance for that in figuring velocity, or for friction, or anything of that kind. I simply assumed that the water, as fast as it is contributed, would be conveyed in this pipeline immediately without any delay. There is no assumption as to the diameter of the pipeline in making the computation. I did not compute the friction losses on the idea of curvature or otherwise.

In addition to length and curvature, other factors enter into the determination of velocity of flow in pipelines, including the character of the pipe surface, whether it is rough or smooth, and of course the head under which the flow is operating, the pressure. There is also, of course, the size—that is, the area of the cross section would make some difference. The size determines that. The head or pressure would take care of the slope. If the pipeline had some abnormal features about it, such as enlargements or contractions, those would of course enter into it. The pipeline might be level as far as the slope is concerned, provided it had head enough at the upper end. I did not make any corrections [fol. 1292] for a non-uniform slope. The bed and the banks of the Tennessee River are the same as ordinary river banks. They are not the same as the inside of a pipeline. I did not make any corrections on that account in my computation. As the river widens or contracts, the area of the water cross section varies. I did not make any correction for that. All of these factors that have been mentioned would have a substantial effect in reducing the velocity of flow in the river.

“Q. And if you had made those corrections the results would have been substantially different than shown in your column headed “inflow” on exhibit 85, would they not?

A. Well, you are assuming a method of procedure which is entirely foreign to the problem as I understand it.

Q. Well, regardless of that will you just answer my question, please?

A. It seems to me that is the only answer that I could make.

Mr. R. T. Jackson: Could I have the question read? I think the witness does not understand it.

Judge Allen: He says that is the only answer he can make.

Mr. R. T. Jackson: It seems inconceivable to me, if he

listened to the question that that is the only answer he could make."

I remarked that the Gilbertsville area has a lot of natural storage. I do not think I have the figure as to the elevation above sea level of the Ohio River during the 1937 flood at its confluence with the Tennessee. A record showing the gauge at Paducah on the Ohio River on February 2d as being 60.8 seems about right. The river stations in the report of the weather bureau show the zero of the gauge at Paducah to be 286.26 feet above sea level, so that the stage of the Ohio at Paducah at that time would have been 346.8 feet above sea level. I am not sure what the elevation [fol. 1293] of the river bed is at the proposed Gilbertsville Dam. I think it is a little below 300, but I am not sure. 295 sounds about right. I could not give the volume in acre-feet between elevation 295 at the bottom of the Gilbertsville Dam and elevation 346.8, which is the height of the backwater from the Ohio River in the 1937 flood, without reference to the volume curves. I do not think I have that here, but it is a very substantial volume. Whether it is more than 1,000,000 acre-feet, I cannot give any figure for it. In answer to the question whether the volume between elevation 295 and 346.8 was naturally stored in the Gilbertsville reservoir during the 1937 flood, I would say that the volume between those elevations, thinking in terms of reservoir levels, is hardly comparable to the volume in the flowing stream. It is the backwater from the Ohio River. The backwater from the Ohio River extended different distances at different times on the flood crest. I am not sure that at the crest in 1937 it extended nearly 200 miles to Pickwick or to what extent it did extend. I can't give the figures of the volume in acre-feet stored at the crest of the 1937 flood by backwater from the Ohio River. There was certainly a very large volume of moving water in the Gilbertsville reach during the flood. I would not say that it was correct to state that as far as this volume between 295 and 347 is concerned, we are just proposing to swap Tennessee water for Ohio water under flood conditions like 1937.

The sketch (offered and received in evidence as Complainants' Exhibit 914) seems to be a photostat of an exhibit which I presented in the Ashwander case. This seems to be a photostat from some Army plan. I think very likely I did introduce this exhibit. I don't recall. I show there in

black at the bottom a large area designated as flood storage displaced by reservoir. I did offer this exhibit with my testimony in the Ashwander case, but I did not make the drawing. I did not offer it in that case for the purpose of [fol. 1294] confusing the court about it. I probably offered it as a helpful exhibit.

The sketch (offered and received in evidence as Complainants' Exhibit 915) I recognize as a photostat of another exhibit which I offered in the Ashwander case with my testimony.

Examination by the Court:

Ordinarily speaking, channel storage would be the amount of storage within the channel itself as the river runs, whereas valley storage would include that and also any upon flooded planes outside of the channel. Channel storage is within the banks but may go on to an abnormal height.

Cross-examination continued:

In Complainants' Exhibit 915, I think that channel storage has been used as synonymous with valley storage. The dotted lines or curves at the bottom of the exhibit show the volume of the valley storage during the flood of 1917 on particular days in particular sections of the river. The solid lines going from Knoxville to Johnsonville show the total amount of valley storage in particular days in that section of the river. That is the top curve that goes up to a much higher elevation.

Defendants' Exhibit 83 is entitled "Volume in peak of Mississippi River, hydrograph 1929 flood". That was a rather moderate flood and was carried entirely within the levees. That was the reason why it was selected. No reduction in peak was needed for any purpose during that flood. In answer to the statement that it is not particularly helpful to know that on a small flood with a sharp peak we could have taken off 1.7 feet by a certain amount of storage when it was unnecessary to take any storage off, I will state that I think it is important to know if that is typical of [fol. 1295] larger floods, and I gave comparisons with the 1937 flood for that purpose. Defendants' Exhibit 83 is nothing more than a mathematical calculation of the volume of peaks of a historical flood. It is a mathematical com-

putation of the peaks down to succeeding intervals of depths below the crest made on the records of an old flood. It is much simpler to make those computations of volumes of peaks of past floods than to predict the volume, duration, or date of occurrence of future peaks.

Redirect examination:

I testified at page 836 of the original transcript of the proceedings in the Ashwander case with respect to Complainants' Exhibits 914 and 915 as follows:

"Q. Well, now, have you available a chart which will illustrate how this surcharge storage is provided to compensate for natural storage, or channel storage, which has been displaced, and how the control of surcharge storage makes it possible to assist in reducing flood peaks?

A. I have.

Q. Now, first, where did that come from?

A. That is (indicating) a reproduction of chart 23 of Appendix B, volume No. 2, House Document 328.

Q. Now, what are they basing their study on there, on the proposed high dams under their plan?

A. This (indicating) is an illustration of the effect of the surcharge of the high dam plan.

Q. Now, explain it briefly, please.

A. It indicates the flood storage in this natural condition, passing down the river, as it would have been if there had been no dam in place. It indicates a sudden volume of flood water, a sort of shunted off or switched off to a high elevation, and held there as long as need be by the gates at the top of the dam.

Q. Now, do you believe that is an accurate picture and representation of how it works?

A. I think it is a good picture of the principle.

[fol. 1296] Q. Now, Mr. Kimball, what is this? Briefly it is entitled 'Tennessee Valley Authority, General Engineering Division, Tennessee River channel storage below Knoxville, storm of 1917, February 4, 1935.'

A. That is a chart which represents the passage of the flood crest, or the passage of the temporary channel storage from Knoxville through to Johnsonville.

Q. Now, is that prepared by you?

A. It was.

Q. And it represents your opinion?

A. It represents the computed storage from the actual 1917 flood and produced by the actual flow records obtained from the U. S. G. S. water supply paper.

Q. Now, what is the particular point that you wish to point out there?

A. This chart represents, by a line which is designated as Knoxville to Chattanooga, the quantity of flood storage impounded within the section between Knoxville and Chattanooga for the successive days indicated in March, 1917; and, in like manner, the storage between the section between Chattanooga and Florence, and Florence and Pickwick, and between Pickwick and Johnsonville are also shown. It will be noticed from this that the maximum storage from the first section between Knoxville and Chattanooga is reached on March 6th. From Chattanooga to Florence it was reached on March 10th; between Florence and Pickwick about March 13th; and between Pickwick and Johnsonville, on March 16th. When the storage reached the maximum between Pickwick and Johnsonville, there was only 48 per cent of the storage retained between Chattanooga and Florence, about 80 per cent between Florence and Pickwick, and only 22 per cent between Knoxville and Chattanooga. The effect of the flood storage, as contrasted with the storage provided by the dams by the surcharge of the river dams, is that the surcharge takes that storage and holds it; whereas in the natural flow of the stream, that storage travels downstream. There was in one of the documents a figure of 83 per cent, as representing the relation between the storage supplied by dams surcharge—

Q. (Interposing.) It was stated the surcharge amounted to 83 per cent of the natural storage.

A. Of the natural storage. That figure really had no significance. It was something like counting as in the population of the cities, those people simply passing through on the passenger trains; because the storage is a moving thing, and the only way to get this capacity throughout the river at any one time is through the operation of the surcharge from the dams."

[fol. 1297] That still represents my opinion. I believe that the 83 per cent of the valley storage which was provided by the surcharge referred to the high dam plan as outlined in House Document 328.

I was asked on cross-examination whether or not by the construction of the Gilbertsville reservoir, for the space between elevation 295 and 347 in the Gilbertsville section, I would not be merely swapping Tennessee water for Ohio water, and I said I did not agree with that statement. In explanation, I can not see any real application of that illustration. The passing of the flood water down the Tennessee at the lower reach was influenced by the valley storage. It was shown that if the peak preceded the peak in the Ohio the valley storage was added to the peak in the Ohio. If the peaks coincided, it would be possible without the valley storage to advance the Tennessee River flood water previous to the peak and thereby get better conditions than are provided through the natural valley storage.

"Q. In other words, Mr. Kimball, in those instances when the crest at Johnsonville on the Tennessee, making the allowance for the day and a half difference in time, and the crest on the Ohio were practically simultaneous in past floods, will you state whether or not it is true that if it had not been for valley storage, if you had had controlled storage instead of valley storage, you could have disposed of the crest on the Tennessee and gotten it by before the crest on the Ohio?

Mr. R. T. Jackson: I object to that question unless it specifies how much controlled storage he had.

By Mr. Fitts:

Q. All right, assuming the controlled storage concerning which you have testified, under the Unified Plan as reported to Congress on March 31, 1936.

Mr. R. T. Jackson: I don't remember that he gave any figure. I still object unless the figure is given.

Judge Allen: He may answer. Overruled.

Mr. R. T. Jackson: May we have our exception, please?

Judge Allen: It is certainly not necessary to repeat the [fol. 1298] figures every time the TVA Unified Plan is mentioned, at this point in this case."

It is true that if you have that assumed amount of controlled storage upon the main stream of the Tennessee, it would be possible to so operate the reservoirs as to either discharge the peak of the Tennessee ahead of the peak on the Ohio, or to hold the peak on the Tennessee until the peak

on the Ohio has passed, whichever under the circumstances was the better.

The reason why I am able to describe the general line of the 1867 flood along the Tennessee River, but was not able to make computations of the reductions in height from storage at Norris and Hiwassee, is that it is necessary, in computations for the reduction possible at the dams, to know not only the stream flow in the main stream but also the stream flow which is contributed by various tributaries, in other words, the day-to-day flow from each tributary to the main stream above the point in question. In order to make those computations, you have got to know the exact flow at the sites of the particular dams involved and on the particular days in question. There are no gauging records at all available for that flood in 1867. The only thing that is available is a record of the flood heights which were gathered from various high-water marks, and some rough computations as to the stream flow on the main river which would correspond to those flood heights. Those, because of variation in conditions between 1867 and more recent times when actual measurements of stream flow were taken, make it impossible to estimate with any accuracy or with sufficient accuracy the reduction by control by reservoirs.

I was asked on cross-examination as to whether my conclusions with respect to the system of detention basins proposed by Mr. Kurtz would be affected if the rate of release during the outflow period were varied from the rate of re-[fol. 1299] lease during the filling period. The fundamental difficulty in operating reservoirs for both Mississippi and Tennessee flood control, especially a reservoir designed with capacity sufficient for local flood protection only, regardless of whether the method of control is automatic or not, is that when required for flood control for local protection, the flows that have just occurred are of the only interest. When the problem is coupled with that of holding back water at remote points, then we have a different proposition, and it becomes necessary to control the outflow from the higher reservoir with respect not only to the local conditions but the remote conditions, and that requires larger storage capacity and control gates. The necessity of providing for repetition in heavy inflows makes it necessary to have a much larger capacity at the beginning of the season, so that we will have the storage space for perhaps

two or three floods between which there may be opportunity to release only limited amounts. As the period progresses, the chance of this necessity for storage decreases, and at the end of the season it becomes a problem of merely protecting for the local points rather than for the local and remote points too.

Defendants' Exhibit 90 is the comparison of the Kurtz Clinch River detention reservoir with the Norris reservoir. As to the levels indicated with respect to Norris, this is prepared from the standpoint of flood control and it represents my opinion as to the necessity of reservoir capacity for flood control without reference to other needs. Any curve for which these points are the basis is a flood control storage capacity curve rather than a filling curve for low water regulation. As to the levels indicated by me on that exhibit for flood control capacity, in my opinion it is feasible to allow a tolerance in a dry or normal year without damaging the effect of the reservoir for flood control. —

[fol. 1300] I was asked on cross-examination certain questions as to the elevations at which Norris reservoir was maintained from January 17 through June of 1937. During that period the water in the reservoir was reduced so that the water level dropped from about 1031 to 1009. There were some considerable difficulties in the release, particularly because of the construction work of the TVA going on in the river at Chickamauga and other dams. The water was released as far as appeared necessary, but, at the same time, limiting it so as to safeguard the operations. When it got to the period of about April 1st, there was no further need of reducing because the flood period was over, and a substantial release was not continued late in the season. The crest of the 1937 flood was reached at Cairo on February 4, 1937. The month of January, according to my recollection, was the wettest season on record at Norris. We had operated Norris partially with a view to protecting the construction work in the lower river at the Chickamauga and Pickwick dams under construction. It was estimated that the flooding of the cofferdams during that period might involve an expense to the government of possibly \$100,000 or \$200,000. There was some inconvenience due to the height of the water in the Norris pool, but no material complaint was made. There have been some demands made on the TVA for damages which aggregate, I believe, something

less than \$600 for damages due to the level in the reservoir in that neighborhood of 1031. The existence of the construction works in the main stream of the river was a temporary condition that will not obtain after the system is completed.

The operation of Norris reservoir was very successful in reducing peaks throughout the Tennessee River, including the construction work at the dams, and also in reducing flood heights in the Ohio at Cairo.

[fol. 1301] Examination by the Court:

“We do not intend to operate at the elevation of 1031 or greater. 1031 would be reached only on very rare occasions.

Redirect examination continued:

Our contemplation is that under normal conditions it will be under 1031. As I understand Mr. Kurtz’ testimony, he did not acquire flowage rights and left the railroads and highways in their existing locations and subject to such floods as would naturally occur by filling the reservoir, without any provision for compensation, as I understood it.

I was asked on cross-examination certain questions with respect to Defendants’ Exhibit 29 in the Ashwander case (Complainants’ Exhibit 912) which was introduced in connection with my testimony in that case. Referring to my testimony in that case at page 831 of the transcript, I was asked the following questions and made the following answers:

“Q. Well, now, when do floods normally occur in the Tennessee Valley, Mr. Kimball?

A. They occur from December through March, or at any time.

Q. Do you have any opinion, knowing generally the period during which they occur, will they—will more of that space at Norris be available for flood control purposes, generally, than just that top part allocated for flood storage?

A. Yes; it is practically certain that a portion of this lower zone of water will be available.”

I would now modify that opinion. I would say that under present conditions that space below that elevation would be dependable, as indicated by this, in the way of flood control. Since the time I testified in the Ashwander case, we have

carried through a very large amount of study and work. We had been working six or eight months at that time. We [fol. 1302] have spent three years on it since that time and have used records in this latter period which were not available in the early period, and our present conception of the problem is, we feel, far superior to that at the Ashwander trial. Referring again to Complainants' Exhibit 912 which is a photostat of Defendants' Exhibit 29 in the Ashwander case, which was introduced during the course of my testimony in that case, I testified at page 833 of the transcript in that case with respect to the main river dams as follows:

"Q. Now, up here you have, still on this figure in the lower left corner of the chart, you have the amount available for flood control. How do you figure that and what does it amount to?

A. That is a depth on the river dams of 10 feet, and which is what we call the surcharge control by the gates on the dam.

Q. Now, what do you mean by 'Maximum leveling of flood control'? You mean that is as high as you can get?

A. That is not as high as it could get. That is as high as probable. There is nothing to prevent it getting higher, if you get water enough.

Q. Yes. Now, how about this probable average level available for Norris there between the red dotted line and the top of the blue space? What is that?

A. Well, that is a probable average water level during the year when there is no necessity for operation for flood control.

Q. Now, is it your idea that all of this space in here (indicating) that ten feet can be used for flood control? Now, if so, how?

A. It is expected that even more than that may be used. When a flood is on the way, the water can be drawn from the pool and the level lowered as far as possible, consistent with a nine foot navigation depth. When the flow is substantial, coming down the river, a flow sufficient in itself to produce a nine foot depth at the upper end, the water at the dam can be lowered below that indicated by the white, lower white line, and when that is lowered to that point or below a depth of ten feet that much more is available for the temporary holding of the flood waters."

That still represents my opinion.

[fol. 1303] Recross-examination:

I testified that Defendants' Exhibit 90 was intended to reflect on the left-hand side my idea of the levels to which the reservoir at Norris should be released after a flood for flood control purposes. On January 17, 1937, it was up to 1031 or a little higher. By February 15, 1937, it had not been brought back to 985 as I show, nor had it been brought back to 995 which I show for March 15th. At no time in the interval, even up to April 15th had it been brought back to 1005, which is the level that I show for 1937. I think it was about 1009 at that time, or about that time. I stated to the Court that this would only reach 1031 on rare occasions. That conclusion was not based on the fact that it exceeded 1031 in the only year it has been in operation, but upon computations of flood during the last 50 years. I also said that I thought this could be operated, if it was drawn down for a dry year. I cannot tell you now whether next summer is going to be as dry as 1925. I do not remember that I said this could be operated if it was drawn down for a dry year. I can not tell on January 15, February 15, March 15, or April 15 of any year whether the next season is going to be as dry as 1925; that is not possible. We can not tell so well in advance when it will be a dry year as we can have a pretty substantial idea as to the conditions affecting floods for some little time in advance.

The river discharge which corresponds to flood stage at Chattanooga is about 200,000 cubic feet per second. With respect to the discharge which corresponds to flood stage in the Clinch River, I know that last winter during the worst period we reached a release of about 40,000 cubic feet per second. That flooded one highway down below. I do not know that under the Weather Bureau records bank-full stage is about 42,000 second feet at Norris dam site. I do not think the Weather Bureau records ever established [fol. 1304] a flood stage at Norris dam site. The Weather Bureau may have established what they considered flood stage at Clinton. I don't remember what the flood stage is at Clinton. It is several miles below Norris. With all the studies I have made of flood control I do not remember whether I ever ran across the flood stage records at Clinton or found out what would be a flood stage at Norris Dam site. I very likely have noted it. 43,000 second feet may be the

flood stage at Clinton. I would not disagree with that being approximately right.

I would not know without referring to the records whether any flood stages were reached at Clinton at any time during the years 1903, 1904, 1905, 1907, 1908, 1909, 1913, 1923 and 1925. Referring to page 674 of the Weather Supply Bulletin, "Water Resources of Tennessee", I find that a discharge of 43,000 second feet was reached twice in 1906.

"Q. Well, I asked you about 1903, 1904, 1905 and then 1907. I am glad to know about 1906, but I didn't inquire about it.

A. No, I don't find it."

I don't find any record of flood stage having been reached at Clinton in 1903, 1904, 1905, 1907, 1908, or 1909. In 1913 the discharge reached 54,000. In 1923 the discharge reached 59,800 in February. The water years begin on October 1st of each year, and I took the figure for February from the year commencing October 1, 1922. I don't find any flood discharge during the year beginning October 1, 1923. Referring to page 290 of the Water Supply Bulletin, I do not find any flows above flood stage at Chattanooga for the water years beginning October 1, 1903, 1904, 1905, 1907, 1908, 1909, 1913, or 1923.

I do not know whether in order to develop the amount of firm power set out in the TVA report of March 31, 1936, the natural low water flow of the Tennessee must be increased [fol. 1305] during the low-water season. I do not remember that. In all the studies I have made of flood control and low water flow in this stream, I made no studies to find out whether it was necessary to store water to add to the low water flow to produce that amount of firm power. I would say that under present conditions a certain part of the storage which I marked as being available at times in my exhibit in the Ashwander case is dependable.

As to whether I have in mind in making that statement the fact that the TVA is not yet serving power under a large number of contracts which it has made with places like Memphis, Chattanooga, Knoxville, etc., I was not influenced by any statement as to power. It is true that my opinion was formed without any information about those contracts or the requirements under those contracts.

I assume that the following is a correct transcript of my testimony in the Ashwander case, page 809:

"The generators at Norris are designed for certain conditions and service. No useful purpose is served by changing those conditions. I am not familiar with power generation, but I suppose that the increase in storage produces an increase in primary power."

I can not say whether it is a fact that the maximum inflow to Norris in 1937 was 43,000 second feet,—or 50,000 second feet. I do not have that record here. The flood flows into Norris may reach 115,000 second feet. That was in the neighborhood of the estimate of the flow at Norris in the flood of 1886.

I also testified that the flood of the Emory was something of an isolated character in which the TVA was not interested or concerned, or something. It is a fact that the flood on the Emory covered a considerable area, but it was of the cloud-[fol. 1306] burst character, as described by the United States Geological Survey reports. It is true that that drainage area of 10,000 square miles is approximately half the drainage area above Chattanooga. I don't remember the amount of rainfall over that area, to what extent it was a heavy storm. The fact that that storm split over the Tennessee and Cumberland watersheds and part of it went down the Cumberland helped prevent the conditions from being more disastrous than they were. It is a fact that the average annual property damage estimated by the engineers on the Emory river is \$350,000 per year, or approximately one-half of the annual property damage estimated for Chattanooga. I don't recall what figures they gave. There is practically no basis for an estimate of an average annual property damage at Harriman because there has been only one flood and that is not sufficient for a determination of an average annual damage. There was a substantial loss of life in the Emory flood, which I did not think reached 50. There were only nine lives lost at Harriman. I know three of those lives were the family of the waterworks superintendent. I don't remember about the other six. The remainder of the 50 were on another stream, if I remember correctly. I am quite sure there were only nine at Harriman. I do not think there were at least 21 on the Emory. I tried to make myself clear that that is not the type of thing which the TVA is concerned with.

I said that I could not put on this 1867 flood where I wanted to show the effect of the flood heights at Chatta-

nooga, because I did not have enough data. We made some study of a large flood as to what might be expected in the future and estimated that it might be 50 per cent above the 1867 flood. We did make some studies and develop the project flood enough so that we had data enough to put the results in case of such a flood on my exhibit. We could have given the results of the computations on the exhibit. We did not do it. I would not say that the reason that we [fol. 1307] could not put anything down about the 1867 flood was because we were in just the same situation with reference to that flood that we would be at the start of any other flood that has not yet happened. If you assume a project flood, it would be hypothetical, such as Mr. Kurtz has in his plan. It is nothing definite, it is hypothetical. It is true that we had even more information with reference to the 1867 flood than we would have at the beginning of a new flood that had not yet happened. I don't remember the total storage in acre-feet above Chattanooga that Mr. Kurtz's 19 reservoirs had. Of course, he had 19 reservoirs and the TVA has but six. I think that it is probably true that he had a great deal more storage in acre-feet than the TVA has above Chattanooga. I don't remember his figures.

(The witness was excused.)

[fol. 1308] O. N. FLOYD was called as a witness on behalf of the defendants and, having been first duly sworn, was examined and testified as follows:

Direct examination:

I reside in Dallas, Texas, am 59 years old, and am in the private practice of hydraulic engineering. I entered the University of Tennessee in 1900, took two years of Civil Engineering course, dropped out one year and worked about six months on the Tennessee River with the Army Engineers near the vicinity of Rockwood Landing, and the balance of the time with the L. & N. Railroad. I then went back to the University and took the remainder of the four year course, and graduated in 1905. I then went back to work for the L. & N. Railroad and the Southern, and all together, before graduating and after, I had about six years experience in

railroad work, usually in relocation, in construction of some double track work. Then, from about 1910 to 1913, I was engaged on drainage and levee projects in the Mississippi Valley, Western Kentucky, Arkansas and Mississippi. In May 1913, soon after the flood at Dayton, Ohio, I went to Dayton as the local representative of the Morgan Engineering Company in charge of surveys of the Miami Valley, making surveys, collecting flood data, hydrological data, and making a study of the 1913 flood at Dayton and in the Miami Valley, and of course, looking forward to working out plans for the protection of the cities in the valley.

For the first four or five years on this work, I do not remember that I had any particular title, I was more or less chief assistant to Mr. Arthur E. Morgan, who was chief engineer on this project, that later was organized legally into what was called the Miami Conservancy District. I had [fol. 1309] charge of field surveys, investigation of dams, making borings, collection of data, and worked more or less with the designing department in coordinating all this data. After the construction started, I might say that this resulted in the building of five dams in the Miami valley and about five million dollars worth of channel improvement, mostly at Dayton, Hamilton and below, Troy, Middletown, Miami, probably some smaller places between. After the construction started, I was in charge of the construction of one dam, the Taylorsville dam above Dayton, and was on the construction committee that worked with the Assistant Chief Engineer and construction manager on all the principal construction problems that came up anywhere over the project. About the time that this work was finished in October, 1922, I went to Wichita Falls, Texas, as Assistant Chief Engineer on an irrigation project, in charge of constructing two large dams and a hundred miles of irrigation canal.

After that project was completed I went to Dallas, Texas, as principal assistant engineer for the City of Dallas in charge of the studies and investigations for a new water supply for the City of Dallas, which resulted in the building of what was called the Gorza dam about ten miles above Dallas, storing a large amount of water for their water supply. This was a five million dollar project. I had an understanding with the City about the consulting engineering position in which I was, when I went there, that after the work was fairly under way, I would enter private practice.

I expected to make that my headquarters. So before this work was finished I formed a partnership with J. L. Lockridge, and in 1926 we became fairly active in handling engineering projects. During that, the principal dam we built or had charge of as principal engineer—was a dam for the [fol. 1310] City of Waco, Texas, for water supply. The reconstruction of the filter plant and building about five miles of 42 inch pipe line. We also worked and supervised the dam for the West Texas Utility Company, for water supply at San Angelo, Texas. We worked at some smaller dams for the West Texas Utility Company, one at Abilene, and one near Vernon, Texas.—I can not think of the name of the town now. We worked out a water supply for the Dallas Power & Light Company which finally developed into the Mountain Creek dam near Dallas. I did not have charge of that, that was built by their own forces.

I was consulting engineer for the contract on two large earth dams that were built above Fort Worth, Texas, partly for water supply and irrigation, but largely for flood control. I was consulting engineer for the contractors who bid on the Madden dam at the Canal Zone, and who were the low bidders. I designed the cofferdams and river control work for the construction of this job and assisted with the selection of plant and operation of the contractor's work. From August 1930 to January 1st, 1931, I was consultant for the Army Engineers at New Orleans on the Bonnet Carre Spillway, which is one of the principal units for Mississippi River flood control for the city of New Orleans. During this time I helped to make studies in the Atchafalaya basin, which is a short cut from the mouth of the Red River down to the Gulf, for the revision of what is known as the Jadwin plan.

In December, 1934, I became consultant for the TVA and have continued on that work ever since, seeing the work about once a month, certain parts of it, sometimes more or less all of it. I am at the present time consulting engineer [fol. 1311] for the Army Engineers on the Sardis Dam, which is being handled by the Vicksburg office, about an \$11,000,000 flood control project. I am also consultant for the Little Rock office of the Army Engineers on the dam on the St. Francis River and several on the Arkansas drainage area in Oklahoma and Colorado. They are all flood control projects. The one in Colorado combines flood control and

irrigation. I neglected to state that in May 1934, I was employed as consultant on what is known as the Red Bluff Dam in West Texas, about a \$2,800,000 irrigation project to store water for irrigation and a small amount of power. The dam has been finished and I am still retained as consultant in a way, that is, to make periodic inspections of the project. I have made a number of studies and reports for flood control, drainage, water supply, small projects that I do not think need be mentioned in detail. My work on the St. Francis is largely for the lower St. Francis Valley and helps the Mississippi to some extent. The ones on the Arkansas have some local benefits and some benefits further down on the Mississippi.

I have worked for the TVA as consultant since December, 1934. I was first called in in connection with the construction of the earth dam part of the Pickwick Dam, to give my opinion on that and on the cut-off of the underlying material, and later continued on through the Pickwick Dam on studies of the foundations, and the cofferdams and general problems that came up. Then before the construction started at Chickamauga Dam and at Guntersville Dam, I made examinations of those for reports on the construction of the earth dam and the cut-off's, and have continued to give more or less attention to those dams during construction of the foundation problems and designs, and sometimes plans [fol. 1312] and things of that sort. I have recently given some attention to the Hiwassee Dam. The Norris Dam was very nearly finished before I came with the TVA, but I was on two or three inspections towards the last, and I was on the final inspection before it was decided to go ahead and fill it and use it. In connection with the Gilbertsville Dam, I studied foundation conditions there and made comparisons between the different sites that had been investigated. I have worked somewhat on the tentative designs and I made a special study of the flood control value of Gilbertsville and the heights that should be used for storage, and so on.

In my opinion, it is desirable to provide flood storage in reservoirs on the tributaries of the Mississippi to increase the protection of the alluvial valley of the Mississippi. In my opinion, the system of projects composed of the TVA dams under construction, constructed, and authorized for investigation, constitutes a practical project for the reduction of flood peaks on the Mississippi. There are three par-

ticular advantages for these projects of the TVA for Mississippi flood control. First, the Tennessee is one of the main contributors to all our floods and there has never been one of the higher floods or bigger floods in Cairo without a substantial contribution from the Tennessee River. The Tennessee River system, as proposed and being carried out by the TVA, will control the floods in the Tennessee River down to its mouth, which is very close to Cairo, making a positive control. In other words, there are no particular errors in timing because the last dam, the Gilbertsville Dam, will be about one day's flow away from Cairo.

As a result of my studies as a consultant, I would consider that an amount of storage at a dam with an elevation of 375 [fol. 1313] is feasible to provide substantial flood storage at the Gilbertsville site in addition to that already provided for in projects constructed or under construction. By that I mean the top of the gates will be 375 so that the water may be 375.

I am familiar with Mr. Bowman's estimates as to the amount of flood storage which it would be possible to secure on the TVA's projects, and I have heard Mr. Woodward's testimony. Assuming a seasonal filling of tributary reservoirs from around 960 up to about 1005 on April 15th, and assuming that in all major flood seasons the main river dams will be drawn down to the minimum navigation level, assuming that method of operation, I think Mr. Bowman's estimate as to the amount of controlled flood storage available is conservative. I consider it feasible to draw down the main stream reservoirs in advance of a flood and thus provide additional storage space below minimum navigation level, especially so with a series of dams as you have on the Tennessee. In my opinion, the storage in tributary reservoirs, such as Norris and Hiwassee, will be of substantial value for Mississippi River flood control. They will not only help to hold back the water that would otherwise reach the Mississippi, but they make the main stream dams along the channel more effective. The main stream dams have a limited amount of storage available at all times, all during the flood season. There are certain floods, the larger floods, that go somewhat beyond the efficient capacity of the main stream dams, and the storage on the tributaries reduces these floods to a volume and strings them out as to time, so that the high dams become more efficient in handling it.

"Q. Mr. Floyd, is it also feasible to draw down the main stream reservoirs, such as Gilbertsville, below the minimum [fol. 1314] navigation levels at times and thus increase the amount of flood storage space available at such dams?

A. Yes, it is entirely possible to draw Gilbertsville dam down, in order not to interfere with navigation there will be need for releasing from Pickwick when it is held by it.

Mr. R. T. Jackson: I move to strike out the answer as the witness has no qualifications to testify as to navigation.

Judge Allen: The motion is overruled. The answer may stand.

Mr. R. T. Jackson: May we have our exception?

Judge Allen: The Court considers in view of the statute, in view of the express provision of the statute with reference to the depth of the channel to be provided, that this witness can answer with reference to navigation, so far as the channel is concerned.

Mr. R. T. Jackson: We submit there is nothing in the statute that makes a consulting engineer an expert for navigation.

Mr. Fly: I am referring, your Honor, only to depth of the channel. I am not referring to any of the other details of navigation.

Judge Allen: The Court considers that a lay person could testify that where he formerly had a foot and a half channel or a 3 foot channel, that a 9½ foot channel or a 12 foot channel was better for navigation for a boat having a draft of six or eight feet.

Mr. R. T. Jackson: If the Court please, I do not want to pursue this, but do not want the Court to be under a misapprehension.

Judge Allen: I just want to give the Court's view that has been expressed silently behind the bench over and over again.

Mr. R. T. Jackson: Since it is now expressed publicly and is so far away from what I understand to be the facts of the case, I think I might express our position.

I do not understand when the Federal Government provides a navigable channel that has a limit of nine feet, that some lay person can come along and say that since they provide nine feet for navigation whereas before it was two, it is no harm to navigation to reduce it to two. Nor do I understand such persons are qualified to say whether a question

of hydraulic engineering might make it impossible for navigation.

[fol. 1315] By Mr. Fly:

Q. Will you please explain, Mr. Floyd, what the advantage may be from the stored water in the tributary reservoirs, such as Norris or Hiwassee, making practicable this draw-down of Gilbertsville and other main stream dams below the minimum navigation depth?

Mr. R. T. Jackson: Object to the question on the ground it is one which the witness is utterly incompetent to express an opinion on.

Judge Allen: Objection overruled.

Mr. R. T. Jackson: May we have our exception?

A. This water stored in the tributary dams, of course, makes it possible to maintain a navigable depth at the headwaters of Pickwick, in case it becomes necessary to draw down or desirable to draw down for flood control to such an extent that the slack water would not extend all the way up to Pickwick. In other words, it would give you this ability that you will not damage the purposes of the system by draw-downs for flood control."

Examination by the Court:

When we construct this system of dams on the main channel of the Tennessee River, that will give continuous nine-foot channel from Knoxville to the mouth. Below Pickwick it is backed up to Pickwick by Gilbertsville. That channel is maintained if you keep the water in Gilbertsville, to about 354. But it is possible if we know floods are coming down the Ohio River, to open the 24 gates at Gilbertsville and let that water down as low as 350, in a number of cases. In some cases also, when that water gets below 352, it begins to seriously interfere with the navigable depth up at Pickwick, or at the upper end of Gilbertsville Lake. Then is when we need an increase of water from above to create a flowing channel deep enough for boats to get up. The water would come immediately from Pickwick, but might be supplied eventually from the tributary storage or from anywhere above or you might have a little flood.

[fol. 1316] Direct examination continued:

“Q. In your opinion, is it an advantageous and feasible operation to draw down the main stream dam, such as Gilbertsville, below their ordinary slack water minimum, navigation level, and then to build up the depths of the water in the upper reaches of the pool, up to the minimum navigation depth, by means of the releases from the tributary reservoirs?

Mr. R. T. Jackson: I object to the competency of the witness to answer as to navigation; and on the further ground the question has already been put and answered.

Judge Allen: Objection overruled.

A. It is.

Mr. Jackson: Exception, please.

Q. And in your opinion, would the storage available at Norris, and which could be made available at Hiwassee, be useful and valuable for that purpose?

A. Yes, if it is needed it is very important.

Mr. R. T. Jackson: I object on the same ground.

Judge Allen: Objection overruled.

Mr. R. T. Jackson: May I have an exception?”

In my opinion, the seasonal filling at Norris and later at Hiwassee during the course of the major flood season is a desirable and feasible operation for Mississippi flood control. We need more flood control capacity at the beginning of the flood season as distinguished from the end.

[fol. 1317] Cross-examination:

The Corps of Engineers, United States Army, have been in charge of the flood control works on the Mississippi River since 1880. It was somewhere about that time that the Mississippi River Commission was legally set up. They have had the authority and responsibility for flood protection measures on the Mississippi River, so far as the Federal Government is concerned, since that time. I do not know how long the Corps of Engineers, United States Army, have had the responsibility for inland waterway navigation and development and operation of navigation works on inland waterways. They have had it farther

back than I know about and ever since I have been in engineering work. I never paid much attention to it before. Before I got into engineering, navigation did not interest me much. I was inland born. Neither before nor since did it interest me much but I had heard some of the discussions.

I have done quite a little construction work in Texas and Arkansas and states in the southwest. A large part of my work has been the planning of these projects and in charge of construction. I would say that most of these projects out in Texas and those places are irrigational or water-supply projects only. Some of them are flood control. There is a good deal of trouble out there with shortage of water for the dry season and the necessity of storing it for irrigation and water supply both. Our rainfall is very irregular. We are liable to have some long, dry periods and then some very severe floods. When I came to Pickwick, which was my first work, I advised with reference to the construction of the earthen part of the dam and the cofferdam construction. I made reports and recommendations about the construction of the earthen part of [fol. 1318] the dam at Chickamauga and Guntersville, and the cut-offs that were made there, and work on foundations. I have inspected the foundations of the dam up at Hiwassee. I came too late to inspect the foundations at Norris.

I stated something about the storage in the TVA Dams but I cannot tell what is the power storage between flat pool and normal pool at Watts Bar or Coulter Shoals. I am not familiar with them. I do not even know what you call "power storage". The flood storage at Chickamauga is 325,000 acre feet, I am not sure that it is between normal pool level and the top of the gates. I do know that part of it is below the top of the gates. I can not tell what the storage is between normal pool level and the top of the gates. I don't know what normal pool level is. I have seen the tables of what the amount of storage is at Hiwassee between normal pool level and the top of the gates, but I don't remember those figures. I have studied those projects and have drawn my conclusions when I had the figures before me. I can not tell what the figure is at Hiwassee without referring to a table. I have not got my working papers with me.

Examination by the Court:

Normal pool level is rather variously used. It is supposed to be an average, as I understand, just as we speak of normal temperature, which is almost never the temperature that we have, or the normal rainfall is spoken of here at this place as being a little less than 52 inches, and out of the whole 70 or 80 years record there will be only a few years, of course, that are even very close to normal. It is a sort of an average, and one man's average might not be [fol. 1319] the same as the other. I don't think of it so much as normal pool. The flood control storage depends on the figures that I used, and in stating flood control and the effectiveness of controlling the floods, it is from the minimum draw-down, that is, the minimum navigation level, the navigation pool level, and the top of the gates. In other words, it is that storage which can be piled on top there during the flood. That is the effective storage in all cases. The storage below that, even down to the top of the concrete, is taken into play as effective storage, especially if we have opportunity to draw that out ahead of the flood and then fill it back up with the flood water.

Cross-examination continued:

As to whether my testimony in response to the questions of the Court expresses my understanding of normal pool level as the term is used in storage reservoirs and power reservoirs, I don't use the term myself. I hear it used.

"Q. I didn't ask if you used it, I asked if that is your understanding.

A. I understand it is a sort of average of the fluctuations up and down.

Q. And that is what you think is meant by normal pool level in a storage reservoir or a power reservoir?

A. Some people I know use it, I don't know just always—it is not a very definite term."

The amount of dead storage at Wheeler would be the amount below the top of the concrete spillway or the bottom of the gates. I would not know how much that is without referring to tables. I don't know exactly what the volume is between the minimum navigation level and the top of the gates at Wheeler. I think it is something over 400,000

[fol. 1320] acre feet. I am not sure about that, I would have to look at the tables. I can't tell how much the total volume of dead storage is in all of these TVA dams constructed, under construction, and proposed, without taking it off tables. I can't tell how much power storage there is in all of these TVA reservoirs constructed, under construction, and included in the plans for construction. I never made any study of power storage and haven't any idea about it;—not anything that would be dependable. It is not correct to say that when I gave my testimony, I did not have any knowledge or idea that could be dependable of how much power storage was included in the storage of the TVA dams and reservoirs. My testimony is based on what I consider to be the effective flood storage, and it has no reference to power storage of any kind. There may be some power storage in that, or power may be gotten out of that; but I never made a study of that.

Assuming that the TVA dams and reservoirs were to provide such storage as would provide 660,000 kilowatts of firm capacity in a dry year such as 1925, and 5,780,000,000 kilowatt hours of firm energy in a dry year such as 1925, I have no idea what would be the remaining storage capacity that would be left after supplying that energy. I never have had any idea at any time during my testimony. I never have considered it. I never heard that until I heard you mention it here in Court. I have been in Court ever since last Thursday, I believe.

When I expressed an opinion about the effect of the storage which I had in mind in these reservoirs as a flood came down the Tennessee River, I did not have a project flood in mind, except, you might say, in a study of Gilbertsville. I considered what we called a project flood, but that was for Cairo rather than for this. Assuming that we had a three-day rainfall of eleven inches with 90 per cent run-[fol. 1321] off over the Tennessee basin, we would get a pretty good-sized flood in the Tennessee River. I have read Mr. Kurtz's testimony on what he would get above Chattanooga, and I see no reason to dispute it. I think it is something close to 700,000 second feet. If it was distributed over the Tennessee basin, I would have to have hydrographs and calculate the acre-feet in volume of that flood that we would have, and to know how many days it was going by, etc. Before I testified as to the volume I

had not calculated what you call a project flood; it was what we designed the spillways from. As to whether such a flood would produce a volume of 20,000,000 or 40,000,000 acre-feet, I would say that both of those figures might be rather large. I think 20,000,000 would be large at Chattanooga; 20,000,000 acre-feet might not be large for the total flood at the mouth of the River. I do not know what it would be.

Assuming that along about the first of March in a certain year we had a number of moderate floods and filled perhaps two-thirds of the storage capacity in the various TVA reservoirs, and that on that date, or shortly thereafter, we had a storm of that character over the Tennessee Valley producing a volume of run-off of 20,000,000 acre-feet, I would let most of it, a good part of it, go by. As to whether I would have to let a great deal of it go by, that is good flood control to let all of the early part of the flood go by. That is just as effective as if we had held it up above. If it is good flood control to let the flood go by, the reason why we spend a lot of money on dams to stop it is that there is a part of it you have to stop to prevent damage, that is the critical part, during the critical peak of the period but that is a small per cent of the total volume of [fol. 1322] the flood. I mean to testify that on the above hypothesis we would take off the peak of the flood. If it is within the reason of probability, such a flood would probably last a couple of weeks at fairly good stages.

I spoke about drawing down pools. On my prediction of a flood with a gauge 18 feet high at Wilson, we could not draw the pool down very much unless we closed the gates at Wheeler. Then we could draw it down very close to 18 feet. If we drew Wilson down 18 feet, I don't know how much water we would have over the upper sill of the lock. If we drew down Wheeler reservoir in the same way, the amount of water which we would have over the upper sill of the lock would depend on how much water was flowing out of Gunter'sville. I don't know as a matter of fact that we would not have 2 feet. I don't know we would, either. There are other conditions there. You have either got to base it on no flow or putting a certain amount of flow into the reservoir. I did not base it on any flow, that is your problem. It is not that we just pull down the reservoir and take out the water and it is the navigator's prob-

lem whether he gets through or not, I am answering your problem. I don't know what the elevation of the upper lock sill is at Wheeler. I would have to look that up. I don't know what the elevation of the upper lock sill is at Wilson. By the upper lock sill at Wheeler you probably mean the sill of the upstream gate of the lock at Wheeler. I don't know whether you mean that or whether you mean the sill at Guntersville, the next dam up. As to whether I, an expert, do not know what the upper sill of Wheeler lock is, I will have to look those figures up for the upper sill of the lock at Wheeler Dam. I don't try to remember, in fact [fol. 1323] it is very dangerous to try to remember an awful lot of figures. I was not trying to evade. I make it a point not to try to remember. Even if I think I remember I usually want to look it up. In any case it is not good engineering practice to try to tell too much from memory. I am not making it a point not to remember when I am asked questions here.

With respect to what the release at Guntersville has to do with the drawing down at Wheeler, I had in mind that you meant the upper end of the navigation channel, when you said upper sill. If you had meant that, of course, then the volume through Guntersville would—the backwater up there, would increase the depth at the upper end of the pool when the Wheeler pool was drawn down low; otherwise it would have no effect. I can not give exactly the actual velocity at the head of the Guntersville pool when it is drawn down to elevation 350 or less at the dam and water is being released to increase the elevation at the head of the pool to 354, but I remember the figures. It was between four and five feet a second, as I recall. I investigated the velocities for 20,000 second feet and for 50,000 second feet. $4\frac{1}{2}$ feet a second would be three miles an hour. There have been some different plans on the amount of water that would have to be released in order to obtain this increase in elevation to 354, and I might be a little mixed on that, but generally if it is not drawn too low, I think 20,000 second feet. I do not know just how far down that would carry us, but to draw down lower than 350, we may have to raise it more than 20,000. I have forgotten. I would rather look that up, but it is somewhere from 20,000 up to 40,000 or 50,000 second feet. I don't think we would ever have to have 50,000 second feet.

[fol. 1324] The purpose of drawing that out at Gilbertsville in order to dump it out at the lower end is that every bit of the water we get out of Gilbertsville ahead of the crest at Cairo just makes our storage that much more effective for flood control. We are dumping water in right behind that, but at a time when the stages are not critical at Cairo and in the lower river. In other words, we have generally about two weeks warning at Cairo before there is going to be a critical flood. Now, they do not know very close on the gauge that far ahead, but they do know whether a flood is going to be serious or not serious. It is during that period that we would let the water out at Gilbertsville or any of the other dams above to get it on down the river before the water got too high at Cairo. There is no point in controlling the water at Gilbertsville until the critical stage is reached at Cairo. So, if the flood is going to 59½ feet, and we can take off two and a half feet, there would be no point in starting controlling until the flood was on the gauge at Cairo at 57. Then we would do all we could at Gilbertsville to hold it at 57, for anywhere from 10 to 15 days, depending on the flood water at that stage, and also whether we can hold it. All the water we can let out before that time, is that much water out of the way, just as effective as though we had control on the tributaries, anywhere else. Of course if we had not had the dam there, that water would already have been down stream. That water would have gone on, but we would not have stopped the later water, that is the trouble. We release just as little of the later water as we can, for two weeks or longer, depending on the shape of the hydrograph at Cairo. And then sometime after the River at Cairo is beginning to go down, depending somewhat on conditions down below, we begin getting rid [fol. 1325] of the water. How long we would hold it would depend a great deal on how much flood came down the Tennessee. We might hold all of it, if we do not have too much, or hold a part of it. We would always hold some of it. How long we would hold it, if we were going to do any good, would depend somewhat on the peak at Cairo. If we are effective at Cairo, we have got to hold throughout the critical period. In other words, if we decide we can take off 2½ feet at Cairo, we have got to hold throughout the whole time that the River would have risen that 2½ feet and gone back down that 2½ feet. That may be a little

longer so as not to inconvenience anything by turning it out too quick.

"Q. Now, Mr. Floyd, in 1937 the peak at Cairo was over 52 for 25 days, wasn't it?

A. That is probably right. I don't see any point in that, you don't have to control that long.

Q. You didn't understand me to ask you whether you could see any point in keeping it that many days?

Mr. Fly: I move to strike out that remark.

Mr. R. T. Jackson: I think it is perfectly proper cross-examination.

Judge Allen: It is not a very courteous question any way.

Mr. R. T. Jackson: I think it is entirely proper. I am sorry if the Court feels that way, but I think it is a question which is perfectly proper with an argumentative witness.

Q. Mr. Floyd, there is no reason to believe that such a peak of 52 feet might not last more than 25 days, is there?

A. The lower stages could last long, by water coming in from the Mississippi, which has occurred on other floods, but the high peaks are not likely to last very long."

[fol. 1326] I have been told how they operated the Wheeler reservoir during the 1937 flood. I think I read some sort of report on how it was operated during the 1937 flood. I recall it was operated so as to add some seven to nine thousand cubic feet per second to the stage at Pickwick and at Cairo. I heard Mr. Woodward say 7,000 cubic feet per second more was going out of Wheeler than coming in. At the same time Norris was holding back more than that. I think under the circumstances Mr. Woodward described there it would be a prudent and sensible operation at Wheeler. The Weather Bureau had reported there would likely be some rain and they were trying to draw down to get ready for another flood. The other flood did not come, but it might have.

"Q. And in the cases where your prediction fails like that, you simply augment the peak, is that right?

A. Mr. Jackson, you can never operate 100 per cent efficiently in works of this kind, because you have got to depend somewhat on your predictions. That is the reason why we always try to have what we are quite often criticized for, excess storage—so-called excess storage."

The fact is we just can not operate these by hind-sight. We do not know when the rains are going to stop. We can not do that. Nobody has yet perfected a system for predicting rains accurately. I have seen the records as to when the largest flood occurred in Chattanooga. I have heard it stated here that it was March, 1867. I think the second largest flood occurred at Chattanooga in March, 1875. The third largest flood at Chattanooga occurred in April, I think, the first few days in April, 1896. I don't remember that the next largest flood occurred in Chattanooga in March, 1917. I think that is right.*

[fol. 1327] If it was necessary to build power storage by March in order to provide 660,000 kilowatts of firm capacity and 5,780,000,000 kilowatt hours of firm energy annually, I could not tell what volume of storage could be relied upon in those upstream reservoirs for a flood coming in March or April. You would have to tell me how far your storage had to run. If that power storage would encroach so far upon the total storage as to leave an inadequate place to take care of the flood, there would not entirely be no dependable flood storage left. Of course if we did not have space for it, a part of it would have to go down.

I am one of the alumni of the Miami Conservancy District. I spent about ten years in that school. Usually we had there during the preliminary stage, I would say, 250 to 300 engineers. Then after the construction started, of course that built up considerably. There was some turnover in the total of engineers who went through the job, but quite a bunch of us were there straight through. That was a system of detention reservoirs with some channel improvement.

(The witness was excused.)

[fol. 1328] CHARLES W. OKEY was called as a witness on behalf of the defendants and, having been first duly sworn, was examined and testified as follows:

Direct examination:

I live at Knoxville, Tennessee, and am principal engineer with the TVA. I am engaged in the Project Planning Division and have been with the TVA since November 1, 1935. My work consists in general of making a study of the in-

fluence of the reservoirs on the land immediately surrounding the margin thereof, in connection with the protection of certain areas from backwater and also in connection with the effect of flood control storage on the Tennessee, the Ohio, and the Mississippi Rivers.

I finished the civil engineering course at the Iowa State College with the degree of Bachelor of Civil Engineering in 1909. In 1914 I submitted a thesis on drainage work and received the degree of civil engineer. The first seven years after graduation I was with the United States Department of Agriculture in drainage investigation work in the Mississippi Valley, stationed principally in Louisiana. This work consisted of technical investigations on the theory and practice of drainage, and surveys and plans for specific projects in the states of Kansas, Mississippi, Louisiana and Florida. As the result of this work, various reports and bulletins were prepared on drainage, both by gravity and by means of pumps. The work also included some investigations in Illinois, Iowa and Missouri. In 1916 I left the Government service to engage in some private work on some reclamation projects on some rivers in South [fol. 1329] Carolina. In 1919 after the close of the War—during which I was engaged on construction work at Nashville, Tennessee, and Mobile, Alabama,—I entered into the private practice of drainage and flood control engineering with headquarters first at Peoria, Illinois, later at Memphis.

I was at Memphis until 1926, the work at that time consisting of general engineering practice, drainage and flood protection work in the States of Illinois, Missouri, Arkansas, Mississippi, Texas and Florida. These projects covered all phases of flood control and drainage work. In 1926 I entered on work in Eastern Arkansas in the management, development, sale and operation of about 50,000 acres of farm and timber land. During that time I was a resident in Eastern Arkansas and the problems that we had to deal with then concerned the Mississippi River flood control along the lower Arkansas River and in Eastern Arkansas. At the close of that work I entered the employ of the TVA and have since been engaged in that work which I have described above.

That 50,000 acres of land which I was engaged in developing and operating as an engineer was very largely in the alluvial valley of the Mississippi. I have made additional

studies or investigations of the nature and extent of the flood problem on the lower Mississippi. From 1926 to 1935 it was necessary to be completely informed about the plans for protection of floods in the Mississippi River Valley, particularly the lower alluvial valley. Since coming with the TVA, I have spent practically a year in making a study of the present status of the flood control problem in the Mississippi River Valley, and the effect of flood control storage reducing the flood stage during the maximum peak and at other times. I have referred to and studied the reports by the United States Army Engineers and the Mississippi River Commission covering flood control in the lower Mississippi Valleys; also reports of private engineers, records of the United States Weather Bureau and records of the United States Geological Survey; also the census reports and other official documents dealing with the territory in the lower alluvial valley from Cairo south.

I can give the number of some of the documents concerning that general problem that I have studied. One on reservoirs is House Document 259 prepared by the Mississippi River Commission. Then there is Document No. 1 of the last Congress by the Army Engineers. The other reports deal with the Jadwin plan and the modified project in the report of 1935 adopted by Congress in 1936. I have also studied a half dozen other official documents concerning the alluvial valley flood conditions in the Mississippi, the backwater areas and that sort of thing. I am personally familiar with the geography and agricultural and industrial development of the alluvial valley. I began residing in Louisiana in 1909 and from then on I was residing a good portion of the time in the alluvial valley, and my engineering practice for 19 years had to do largely with the lower alluvial valley. I have had an opportunity to observe personally the effects of floods in the valley. I lived in the valley and observed the floods in 1913, 1916, 1926, 1932, 1927 and 1937—during those years of great floods.

The chart (offered and received in evidence as Defendants' Exhibit 91) shows the levee system, rivers, highways, [fol. 1331] railways, the protected valley land, the unprotected valley land and the backwater area subject to flood waters in the Mississippi alluvial valley. The information set forth thereon was taken from the official reports and maps of the United States Army Engineers and Mississippi River Commission. What the exhibit purports to show is indicated

by the items listed in the legend. This chart shows what is generally considered to be the alluvial valley of the lower Mississippi River, from Cape Girardeau and Cairo to the Gulf of Mexico. The stippled area to the right and left of the middle portion of the map is the upland bordering the alluvial valley. Starting at Cairo, this border goes to the south and west through Poplar Bluff, then on down to the lower end of the map. The white area within the two shaded portions is the alluvial valley, which is planned to be protected by the modified and adopted project of the United States Army Engineers. In this white area there are a few spots of shaded area, which are some ridges or high land which lies within the alluvial valley. The Mississippi River and principal tributaries are shown meandering through the Valley in blue color. The dark brown line is a representation of the location of the levees of the modified adopted project. On the left side the levees start a little southwest of Cairo and then come down the west side of the river to the mouth of the St. Francis River where there is a gap left for the St. Francis to enter. It then again resumes at Helena and goes down the left side until it is cut off for the Arkansas and White Rivers to enter. Then below that, the levee starts at a point near Pine Bluff, going down river, leaving a gap [fol. 1332] just above the mouth of the Red River so that that river can enter. On the east side, the areas of overflowed land are rather narrow from the vicinity of Cairo to Memphis. There is just one small area starting at Hickman, with a levee protecting a relatively small area from Hickman toward Memphis. A levee starts just below Memphis and continues to just above Vicksburg where the Yazoo River is allowed to enter. From there down, there is no levee on the east side of any consequence until you get to Baton Rouge. From there the levee is continuous down that same bank practically to the Gulf. On the west side below the Red River, there is a levee on that bank, then the Atchafalaya River, which is a short river to the Gulf, is taken off from the Red River just above the junction with the Mississippi, there is a system of levees which take the flood waters to the Gulf.

The principal United States highways are shown in and adjacent to the alluvial valley by heavy red lines; the railroads are shown by dark blue cross-hatched lines. These are just the principal railroads and highways. The popu-

lation residing within the alluvial valley is 2,242,000, according to the census of 1930. The total acreage is approximately 20,000,000. In its natural condition without levee protection, this entire valley from Cairo to Cape Girardeau south is subject to flooding, except the small ridges, or darkly shaded line, which I have heretofore indicated.

Examination by the Court:

The population I have mentioned would include the residents of cities below the flood plane of the Mississippi; that would include all of New Orleans and part of Memphis. It includes a part of the population at Memphis of 287,000 and [fol. 1333] the New Orleans population of 450,000.

Direct examination continued:

The white areas on the map depend on the levees for protection, and these white areas are planned to be protected by that levee system. The areas on the east side of the river that are shaded pink are without protection from the Mississippi floods by levees, and the areas between the levees along the river have no protection from floods. 12,000,000 acres of land are designed to be protected by the adopted project.

At the upper end of the map at Cairo, there is first, the Birds Point-New Madrid floodway. This is shown on this map in dark gray. When the floods at Cairo reach a moderate height only, this land is protected by the existing levee system. But when it reaches a stage of 55 feet on the Cairo gauge, the levee across the entrance to that floodway is expected to be overtopped and then the water will flow into that floodway and that land will have the full effect of the flood. The Government acquired only the flowage rights in the Birds Point-New Madrid Floodway. The owners of the land continue to live there, cultivate the land just as they did before the flowage rights were obtained. So when that was flooded last January, these people had to move out and that property was badly damaged. Starting in the vicinity of Eudora at the Louisiana-Arkansas line, is another floodway which has for its purpose relieving the Mississippi River when the river levee system is unable to confine the flood. That purpose is just the same as the Birds Point-New Madrid floodway. Then, below the junction of the Red River with the Mississippi, and

where the Atchafalaya takes off, there is another floodway called the Atchafalaya floodway, which will be used for relief purposes when the flood is too much for the levees of [fol. 1334] the Mississippi to confine. Eudora and Atchafalaya floodways are inhabited and cultivated.

I mentioned that when the levee approached the south of the St. Francis River on the west side, just north of Helena, a gap had to be left in the river levee to allow the St. Francis River to enter the Mississippi. At times of great flood on the Mississippi River, the water backs around the end of this levee and covers the territory indicated on this map as a stippled yellow. The same is true at the mouth of the Arkansas, at the mouth of the Yazoo just north of Vicksburg, at the mouth of the Red River, about half way between Natchez and Baton Rouge on the west side of the river, and then down in the lower reaches of the Atchafalaya floodway there is an area there covered by back-water.

Starting at the north end of the valley, the first city of any magnitude which is subject to flood is Cairo, with a population of about 15,000. It is a railroad and highway center for traveling north and south in the alluvial valley, and in the east and west directions. It is also a river-rail transport point, because Cairo is situated at the edge of the change in railroad rate zones. At that city there are a large number of wood-working plants, whose annual production is about \$9,000,000. The City is from 15 to 25 feet below flood stage in the Mississippi River, and without levees the town would not exist. At times of high water the town is entirely surrounded, because Cairo is protected by a ring of levées, so there is water all around it. Coming downstream, Carruthersville is a town of five or six thousand people, wholly below the flood plane of the Mississippi [fol. 1335] River. It is a distributing center for the agricultural territory surrounding it, and also a market center for that territory. Other towns within that part of the valley are New Madrid, Blytheville, and Jonesboro, as shown on the map.

At Memphis, on the east side of the river we have a city which is largely on high land, but whose industrial and railroad territory is on lower ground and subject in part to floods of the Mississippi River. A part of this low area has been protected by levees, but the last flood of 1937

showed these levees to be of insufficient height. Memphis is a great industrial city and the greatest internal cotton market in the United States. It has a population of nearly 300,000 people. It is a center of distribution for the alluvial valley in that part of the country. It is a railroad center and a highway center, and, as I stated before, a good part of its industrial area is below the flood plane of the Mississippi River, and quite a bit of its residential district in the low areas is subject to flooding by the Mississippi River.

Going south we have Helena, Clarksdale, Greenville and Arkansas City, towns of five to fifteen thousand, which are distribution centers and market centers for the territory surrounding them. These cities have cotton gins and compresses, saw mills, and cotton oil mills to serve the adjacent territory. New Orleans is the greatest city wholly within the alluvial valley, about 450,000. It has an industrial production of about \$150,000,000 a year. It is a railroad center and a highway center for the lower territory. It is from 5 to 20 feet below the maximum flood stage of the Mississippi River, and since its foundation in 1717 has depended upon levees for its existence as far as floods are concerned.

[fol. 1336] By Mr. Fly:

"Q. What is the total mileage of railroads in the alluvial valley subject to flood hazard?

Mr. R. T. Jackson: I object to that as irrelevant and immaterial.

Judge Allen: He may answer. Objection is overruled.

Mr. R. T. Jackson: Exception, please.

A. The total mileage of railroad within the alluvial valley and subject to flood were there no levees, is 4,200 miles, of which 2,145 miles is main trans-continental lines."

I mean they are interstate lines. That entire mileage is subject to flood hazard. From Memphis south, we have the Illinois Central and the Yazoo & Mississippi Valley Railroad. On the west side of the river from Cairo down, we have the St. Louis & San Francisco line from St. Louis to Memphis, and we have the Missouri Pacific line in the same territory. We have the Frisco from Memphis going toward Kansas City and also towards Texas, and we have

the Missouri Pacific from Memphis to Little Rock. Then in the lower river on the west side, we have the Missouri Pacific from Pine Bluff and Arkansas City towards New Orleans. At New Orleans we have the New Orleans & North Eastern, and the L. & N. coming in from the east, and we have the Texas & Pacific and Southern Pacific coming in from the west, and also the Louisiana & Arkansas Railroad coming in from the northwest.

"Q. What is the total mileage of highways in the valley subject to flood hazard?

Mr. R. T. Jackson: We object to that as irrelevant and immaterial.

The Court: He may answer.

Mr. R. T. Jackson: Exception.

A. The total mileage of U. S. Highways within the alluvial valley is 1950 miles. In addition there are 6,600 miles of improved state and county highways."

[fol. 1337] There are a great number of interstate highways in the alluvial valley subject to flood hazard. These highways, the United States highways particularly, are means of travel across the southern United States. At Memphis we have three highways which are interstate in character. At Vicksburg we have one, and at Natchez one, at Baton Rouge one, and at New Orleans two. Then in a north and south direction, we have two interstate highways on the west side of the river going up through the alluvial valley and two part of the way on the east side.

By Mr. Fly:

"Q. What is the annual value of the cotton crop in the alluvial valley?

Mr. S. D. L. Jackson: Objection for the reasons previously stated.

Judge Allen: Objection overruled. He may answer.

Mr. S. D. L. Jackson: Exception.

A. It averages approximately \$250,000,000 a year.

By Mr. Fly:

Q. How is that cotton crop disposed of?

Mr. S. D. L. Jackson: Objection.

Judge Allen: He may answer.

Mr. S. D. L. Jackson: An exception.

A. The most of it goes into interstate commerce.

By Mr. Fly:

Q. By that you——

Mr. S. D. L. Jackson: Just a moment. I move that the answer be stricken. That is an obvious conclusion.

Judge Allen: What do you mean by going into interstate commerce?

The Witness: Well, the records of the Census Bureau show that 55 per cent of the cotton of the United States is exported. They also show that about that percentage goes into states beyond which it was raised.

[fol. 1338] Mr. S. D. L. Jackson: I still move that the answer be stricken. It now appears that he does not know anything about the cotton raised in this alluvial valley and he is just speaking generally of cotton that may be grown over in Texas or in South Carolina.

Judge Allen: Are you speaking of the cotton grown in this valley?

The Witness: I am speaking of both, your Honor. I have resided for a good many years in the alluvial valley and I know from personal observation and seeing it in processing, and seeing how it is shipped out. I worked with a company for ten years which is engaged in the business of cotton exporting.

Judge Allen: You will not deny that the cotton goes into interstate commerce, Mr. Jackson?

Mr. S. D. L. Jackson: I suppose some of it does, but I don't know that this does.

Mr. S. D. L. Jackson: I renew my motion to strike.

Judge Allen: The answer may stand, and you may have your exception.

By Mr. Fly:

Q. What is the total length of telephone and telegraph lines within the valley subject to flood hazard, Mr. Okey?

Mr. S. D. L. Jackson: Objection.

Judge Allen: Overruled.

Mr. S. D. L. Jackson: Exception.

A. The total mileage within the alluvial valley of telegraph and telephone lines is 8,000 miles.

By Mr. Fly:

Q. What is the total number of United States Postoffices in the valley subject to flooding?

Mr. S. D. L. Jackson: Objection.

Judge Allen: Objection sustained.

Mr. Fly: I ask your Honor to take judicial notice of the fact that there are 656 postoffices in the valley in the area subject to flooding. Will the Court take judicial notice?

[fol. 1339] Judge Allen: The Court will certainly take notice that there are some postoffices.

By Mr. Fly:

Q. What percentage of the alluvial valley was under water in the 1927 flood, Mr. Okey?

A. 60 per cent.

Mr. S. D. L. Jackson: The same objection.

Judge Allen: Overruled.

Mr. S. D. L. Jackson: Exception.

By Mr. Fly:

Q. Have any studies been made of the tangible damage suffered in that flood?

Mr. S. D. L. Jackson: May I have an objection and exception to each of these questions?

Judge Allen: Make your objection each time, please. The Court in this case does not want to get lost in a maze of general objections.

By Mr. Fly:

Q. State what estimates were made, Mr. Okey.

Mr. S. D. L. Jackson: Objection, for the same reasons.

A. The United States Weather Bureau in the Monthly Weather Review supplement No. 29 estimated the total damage of the 1927 flood as \$255,000,000 tangible damage.

Mr. S. D. L. Jackson: Move to strike that answer. Apparently he is just reading from a book.

Mr. Fly: It is probably better than his own opinion.

Mr. S. D. L. Jackson: Undoubtedly it is.

Judge Allen: The answer may stand.

Mr. S. D. L. Jackson: Exception.

By Mr. Fly:

Q. What particular states were affected by the 1927 floods Mr. Okey?

Mr. S. D. L. Jackson: Objection.

Judge Allen: He may answer.

Mr. S. D. L. Jackson: Exception.

A. The 1927 flood surrounded and isolated the city of Cairo. It also covered a portion of the low-lying areas of Memphis. The crevass in the levees in the east side of the [fol. 1340] river above Greenville, Mississippi, covered all the towns from there south to Vicksburg, about 15 of them, with a population of from 1,000 to 15,000. The crevasses on the west side of the river below Pine Bluff covered all the cities in the alluvial valley on the west side down as far as the mouth of the Red River. The crevasses in the levees on the west side of the river, on the south bank of the Red River, and the west bank of the Mississippi covered a number of cities in the territory from there south, including New Iberia, Morgan City, and other towns in between.

By Mr. Fly:

Q. Please state how frequently floods of substantial magnitude have occurred in the Mississippi Valley.

Mr. S. D. L. Jackson: Objection, for the same reason.

Judge Allen: He may answer.

Mr. S. D. L. Jackson: Exception.

A. In the last forty years floods have occurred of major magnitude in the lower alluvial valley in the years 1897, 1907, 1912, 1913, 1916, 1922, 1927 and 1937, a total of eight in forty years, making the average of once in five years.

Q. Has the levee system been entirely successful in the past?

Mr. S. D. L. Jackson: Objection.

Judge Allen: The Court feels we do not need to go into a general discussion of the levee system. We have heard a good deal about that in time.

Mr. Fly: Your Honor, I think this is of some importance. This witness would testify that in each great flood, with the exception of that of 1937, one or more crevasses have occurred in the levee system, and many millions of acres of land were covered with flood water. I think that is a significant fact, your Honor, and I think he ought to be permitted to testify.

Judge Allen: He may answer that one question.

Mr. S. D. L. Jackson: May we have our exception. I might point out, if your Honor please, we object to permitting this testimony to go in, as it simply necessitates our going into an extensive history of the floods, which I think we would be entitled to do under the Court's previous ruling.

[fol. 1341] Judge Allen: He may answer.

Mr. S. D. L. Jackson: Exception.

A. In each of the great floods, crevasses have occurred on some portions of the river, with the exception of 1922. During that year they managed to get by without any serious crevasses, and 1937.

Q. And covered a substantial acreage of land?

Mr. S. D. L. Jackson: Objection.

Judge Allen: He may answer.

Mr. S. D. L. Jackson: Exception.

Q. Did those floods cover a substantial acreage of land behind the levees?

A. Yes, each flood, on a crevass through the levee, covered large areas of agricultural land.

By Mr. Fly:

Q. State whether or not the discharge from the Ohio at Cairo in the 1937 flood exceeded the predicted discharge against which flood protection had been provided?

A. It did.

Mr. S. D. L. Jackson: We note an exception.

Judge Allen: It may stand."

The existing levee system does not provide flood protection to the entire alluvial valley.

"Mr. Fly: Let me ask the witness what percentage of the alluvial valley is protected by the levees.

Mr. S. D. L. Jackson: I object.

Judge Allen: He may answer.

Mr. S. D. L. Jackson: We have had an engineer from there on the stand. This fellow has not any qualifications—this witness has not any qualifications about those things.

Judge Allen: He may answer.

Mr. S. D. L. Jackson: We note an exception.

A. The modified plan is designed to protect only 60 per cent of the alluvial valley.

By Mr. Fly:

Q. How much freeboard above the maximum flood estimated before 1937, is provided by the levee system?

[fol. 1342] Mr. S. D. L. Jackson: I object for the same reason previously stated.

Judge Allen: He may answer if he knows.

A. The levee grade as planned provided only one foot freeboard, in parts of the levee system it did not provide that much.

Q. Now, is the freeboard at Cairo under the present projects sufficient to protect against the maximum predicted flood?

Mr. S. D. L. Jackson: Objection.

Judge Allen: He may answer.

A. It is not.

Mr. S. D. L. Jackson: Exception.

Q. In your opinion, would the reduction of two feet in the flood heights have any substantial effect upon the safety of the levees.

A. It would have a very substantial effect.

Mr. S. D. L. Jackson: Just a moment, please. I did not know you had finished your question. I object to it, first, immaterial; second, this witness is not qualified; third, there is nothing to show a reduction of three feet.

Judge Allen: What is the objection to the qualifications of this witness?

Mr. S. D. L. Jackson: This witness, I do not think he has shown he knows anything about flood control, anything of that kind, certainly from the recital of his qualifications. He has been down in Louisiana working around for the

Tennessee Valley Authority, working for the Government, but I do not think there is anything further that justifies his giving his opinions as to what might be a flood crest at Cairo, or how much anything on the Tennessee might affect it, or how much a two foot reduction might help the situation."

Examination by the Court:

I joined the staff of TVA the first of November, 1935. Since then my work has been first, as I stated, in connection with the effect of reservoirs on the lands in and around the [fol. 1343] border. Then for the better part of a year I made an intensive study of the effect of flood heights reduction on the alluvial valley or lower Mississippi River which supplemented the nineteen years practice I have had on the flood control and drainage within that valley.

Cross-examination:

My study consisted in part in reading reports:

Direct examination continued:

I visited the valley and saw some of the floods. I was in the valley at the time of the 1937 flood. I viewed a part of the valley a part of that time. I made a study of it then. I have been studying this problem intensively for almost a year.

Cross-examination:

The 1937 flood is one where the levees did not break except to flood the New Madrid floodway and break the levee at Slough Neck near Tiptonville, Tennessee.

"Judge Allen: He may answer. The objection is overruled.

Mr. S. D. L. Jackson: An exception. I would also like to add as a ground of my objection, the question is so indefinite, it does not fix the place. I move the answer given before I could state my objection be stricken.

Judge Allen: The answer will stand. The objection is overruled."

[fol. 1344] Direct examination continued:

"Q. Mr. Okey, do you consider the reduction by at least two feet of the flood heights on the Mississippi at Cairo and below an important safety factor for the levee system?

Mr. S. D. L. Jackson: Objection for the same reasons previously stated to this line of testimony yesterday.

Judge Allen: He may answer.

Mr. S. D. L. Jackson: Exception.

A. Reducing the floods two feet would be a very substantial benefit to these levees because the flow line of the project flood is within a foot of the top of the levee on a portion of its length and above the top of the levee on other portions, and this reduction is necessary to make the present levee safe.

Q. Now, apart from this important safety factor, are there additional specific types of benefits which would result from this reduction of flood heights?

Mr. S. D. L. Jackson: Objection, for the same reason stated.

Judge Allen: The objection is overruled.

Mr. S. D. L. Jackson: Exception.

A. There are in the Valley areas which are not protected by the levees at all, and each additional foot of flood height floods additional land, so that a reduction of the flood heights would relieve a considerable area from flood damage, and that in the aggregate amounts to—the average flood height will reduce two feet, and that amounts to about 100,000 acres annual reduction in the amount flooded.

Mr. S. D. L. Jackson: Just a moment, please. If Mr. Okey is just reading his testimony, I want to object.

Q. Will you tell the Court what you have got there, Mr. Okey?

A. I have some notes on these voluminous figures. I can't keep them all in my memory with certainty, and so I have to make some notes so I can testify.

[fol. 1345] Judge Allen: If you are simply refreshing your memory on figures or dates or items of that kind, that is permissible, but the Court will not permit witnesses to read testimony."

I have not read my testimony in response to any of these questions.

"Q. What effect in protecting additional acreage would the reduction of flood heights of at least two feet accomplish, Mr. Okey?

Mr. S. D. L. Jackson: The same objection for the same reasons.

Judge Allen: The objection is overruled.

Mr. S. D. L. Jackson: Exception.

A. A reduction of flood heights two feet would reduce the amount overflowed about 100,000 acres annually.

Q. Assuming the same reduction in flood heights, would the use of the floodways which you have described be affected?

Mr. S. D. L. Jackson: The same objection.

Judge Allen: Overruled.

Mr. S. D. L. Jackson: Exception.

A. Yes, the modified adopted project contemplates that the Birds Point-New Madrid floodway would be used for releasing the floods in the main river once in ten years. If the floods are reduced two feet, this floodway would be used on the average once in 20 years.

The Eudora floodway would be used, according to the modified adopted project, once in twelve years. If the floods were reduced two feet on the basis of past experience this floodway would be used only once in 19 years.

The Atchafalaya floodway in the modified adopted project would be used about once in 15 years. If the floods are reduced two feet on the basis of past experience this floodway would be used but once in 28 years.

By Mr. Fly:

Q. Would this same assumed reduction of flood heights have any effect upon the backwater areas?

Mr. S. D. L. Jackson: The same objection and exception. [fol. 1346] Judge Allen: The objection is overruled.

A. Each foot of reduction in the flood heights of the river reduces the height of the backwater going around the end of the levee where the main tributaries enter the river. If the flood heights of the river are reduced two feet, the average annual reduction in amount of land flooded in the backwater areas would be 423,000 acres.

By Mr. Fly:

Q. What effect upon the difficulty and cost of maintaining the levee systems would be produced by this assumed reduction in flood heights?

Mr. S. D. L. Jackson: The same objection.

Judge Allen: Overruled.

Mr. S. D. L. Jackson: Exception.

A. At each great flood on the Mississippi River, high water maintenance expense is encountered to keep the levee in condition to withstand the flood and to raise it in case the water gets higher than the levee. Past experience shows that this expense mounts very rapidly with the increasing flood. For instance, in 1927, a total of \$4,180,000 was spent on high water maintenance expense in order to safeguard the levee and take care of the incidental troubles that came with the high water.

In 1936 a total of \$11,000,000 was spent by the various Governmental agencies, without including the amounts expended under the direct jurisdiction of the Mississippi River Commission. The average of these experiences in the past shows that if you would reduce the flood heights two feet on the average that would reduce the annual average expenditure about \$225,000.

Mr. S. D. L. Jackson: I move to strike that answer. I don't think that it was responsive to the question.

Judge Allen: It may stand.

Mr. S. D. L. Jackson: Exception.

By Mr. Fly:

Q. What effect would this assumed reduction in flood heights have upon seepage from the levees?

Mr. S. D. L. Jackson: Objection for the reasons previously stated.

Judge Allen: Overruled.

Mr. S. D. L. Jackson: Exception.

[fol. 1347] A. When the high water rises above the land and comes against the levees on the Mississippi River the water soaks under the levees because they are largely founded on sand and gravel, and the water rises then in fields back of the levee and affects the land so that crops cannot be raised on it. Sometimes the seepage water appears in the fields two or three miles back of the levee. I have seen the water spouting out of the fields two miles back of the levee. So, any reduction in the average height of the flood will reduce the amount of the seepage.

By Mr. Fly:

Q. In your opinion, would the assumed reduction of at least two feet in the flood heights be an important factor in reducing seepage under the levees?

Mr. S. D. L. Jackson: Objection for the reasons previously stated, including the additional ground that the witness is not qualified.

Judge Allen: Overruled.

Mr. S. D. L. Jackson: Exception.

A. It would.

By Mr. Fly:

Q. Now, the specific items of benefits which you have listed are in addition to what you have termed the important factor of over-all safety of the levee system, is that right?

Mr. S. D. L. Jackson: The same objection.

Judge Allen: He may answer.

Mr. S. D. L. Jackson: Exception.

A. They are.

Judge Allen: Let the record show that Mr. Okey's cross-examination will be deferred until January 3rd, in view of the situation which has developed. Counsel for the Authority have informed us that they have practically no documentary evidence to introduce, except such as may come in explanation of testimony of some witness, and therefore, it cannot be introduced now, the Court will recess at this time, and not take further testimony until January 3rd. We wish to emphasize to you that we expect to carry out the program as announced. We will require counsel to present proposed findings of fact and conclusions of law at the conclusion of the testimony. And we reiterate this now, so that this extra time may perhaps be used in that work.

And we want to remind counsel on both sides again that the Court has requested in connection with every request for finding of fact, which referred to testimony or an exhibit, and of course, they all must refer to some testimony or some exhibit, that the Court be given a citation of the [fol. 1348] page in the record where such testimony is given, or to the number of the exhibit.

The Court will also expect to proceed with the argument upon the conclusion of the testimony. In other words, the

break-down of the case for these two days does not change the necessary program of the Court for this case.

Mr. Fly: I assume, your Honor, any written briefs or written argument, would need to be prepared and presented at the time of the argument.

Mr. S. D. L. Jackson: May I understand aright, what was the question?

Mr. O'Brian: That briefs will be submitted at the time of the final argument.

Judge Allen: The Court will expect final briefs to be submitted at the time of the argument. In other words, the Court, after argument wishes to go into the case and finally dispose of the case."

I have personally made a study of the businesses and industries located within the alluvial valley of the lower Mississippi, particularly in the states along the Mississippi River, with particular respect to the state of origin of the materials used in those industries and businesses and the states in which those manufactured products are normally shipped.

"Q. Will you describe briefly the nature of those industries and business, the sources of the raw materials, and the markets in which those products are normally marketed?

Mr. R. T. Jackson: We object to that, as irrelevant and immaterial and involving collateral matters.

Mr. Fitts: May it please the Court—

Judge Allen: He may answer.

Mr. R. T. Jackson: May we have our exception.

Judge Allen: You may have your exception.

A. The principal industrial businesses of the towns along the Mississippi River consists of woodworking and manufacture of wood products, the warehousing and merchandising of cotton and the processing and manufacturing of [fol. 1349] cottonseed oil and cottonseed products. The first industry, that of woodworking, is in the cities of Cairo, Hickman and Memphis, and Helena and Greenville. The raw material in the shape of logs is brought in by river and rail from the states of Indiana, Illinois, Tennessee, Kentucky, Missouri, Arkansas and Mississippi. The logs are manufactured into lumber and then into finished products, such as flooring, house finishing and furniture. These

finished products are shipped throughout the United States. The second industry, that of cotton merchandising and warehousing—

Mr. R. T. Jackson: We understand our objection also goes to the competency of this witness to testify on this line.

Judge Allen: You may have your exception.

A. (Continuing.) —goes on in these same cities and other smaller river towns, the cotton being brought in from the five states of Missouri, Arkansas, Tennessee, Mississippi and Louisiana, and stored in warehouses and then it is shipped, after being compressed, to the textile mills, in the Eastern and the Southeastern United States and to foreign countries. The cottonseed oil and cottonseed cake industry gets its raw material from the cotton gins of these same five states, and the oil is taken from the seed and the cottonseed oil shipped to all parts of the United States for processing into butter and lard substitute, and into other products where the cottonseed oil is used. The cottonseed cake and meal goes to all parts of the United States for stock feed in interstate commerce.

Q. Mr. Okey, can you state to what extent, if any, these industries which you have described are located within the flood plane?

Mr. R. T. Jackson: Same objection.

Judge Allen: Overruled.

Mr. R. T. Jackson: Exception.

Judge Allen: You may have your exception.

A. (Continuing.) The industries in all the towns with the exception of the city of Memphis are below the flood plane of the Mississippi River and subject to flooding, with the exception of the protection given by the system of levees.

Q. Can you state, Mr. Okey, whether in your opinion [fol. 1350] a reduction in flood height in major floods of two feet at Cairo, Illinois, down to Helena, Arkansas, would be of substantial benefit in reducing flood hazards to these industries and businesses which you have described?

Mr. R. T. Jackson: I object to that because it calls for a conclusion which, if relevant or material, invades the province of the Court.

Judge Allen: Repeat the question.

Mr. Fitts: The question was this, may it please the Court, I will reframe it: Mr. Okey, can you state whether or not in your opinion a reduction in flood height upon the lower Mississippi of as much as two feet, extending from Cairo, Illinois, to Helena, Arkansas, would be of substantial benefit to these industries which you have described.

Mr. R. T. Jackson: I renew the objection.

Judge Allen: Objection overruled. You may have your exception.

Mr. R. T. Jackson: Exception please.

A. It would be of substantial benefit."

[fol. 1351] Cross-examination:

I am an engineer in the Project Planning Division of the TVA and as such am one of the force under the supervision and direction of Mr. Bowman, who testified in this case. My work falls within that division as described by Mr. Bowman on the witness stand. I graduated in 1909 from the Iowa State College, which is in part the Agricultural College of the State of Iowa, and is also the State Engineering College. It is located at Ames, Iowa. It has both an Engineering and an Agricultural Department. Iowa State University at Iowa City has an Engineering Department, and that is where Mr. Woodward was Professor. Iowa State College has a course in drainage. I am not sure about the curriculum at Iowa State University. Iowa State Agricultural College at Ames does have a course in land drainage and what is generally known as drainage engineering. Drainage engineering has to do, in part, with draining sloughs and wet lands with ditches and pumping so that it may be used for agricultural purposes. That would be one activity of a drainage engineer. I have had something to do with drainage engineering of that character in the State of Iowa, most of my practice was out of that state. I haven't any knowledge whether the result of the drainage engineering in Iowa was permanently to lower the water table in the State of Iowa seven feet or more to the irreparable damage of the agriculture there in drought seasons. Of course, when you drain land, you lower the water table sufficiently to grow crops. That is the purpose of the drainage. It has never been conclusively demonstrated to my mind that you also frequently destroy the balance of nature

between sloughs and the other lands that did not require artificial drainage.

From 1909 to 1916 I was a drainage engineer with the U. S. Department of Agriculture and my work had to do with [fol. 1352] the matter of reclaiming wet lands for agricultural uses, and consisted of both investigation of the theory and practice of the science of drainage, and also the demonstration of these principles by sample drainage projects throughout the various states of Mississippi, Kansas, Louisiana and Florida, which sample drainage projects were put in under the direction of the Department of Agriculture engineers to demonstrate the success of that sort of work. The projects ran into several thousand acres at times. I continued with that work up through 1916 and during that time I wrote two bulletins published by the Department of Agriculture over my name on soil drainage. They had to do with draining of wet lands by ditches and by pumping. From 1916 to 1918 I was privately employed as a superintendent of construction on a drainage district at Whitehall, South Carolina. My title was engineer. That was a district to reclaim some of the wet swampy lands there for agricultural uses.

My next experience was as an assistant superintendent of construction at the Old Hickory Powder Plant at Nashville. I was there during the war. That had nothing to do with land drainage or anything of that character. After that I had a job as assistant superintendent of construction in the shipyard at Mobile and that had nothing to do with land drainage at all. It was a shipbuilding enterprise.

After I finished the job with the shipyard, I entered the employ of the Elliot & Harmon Engineering Company at Memphis as Vice President and Assistant Chief Engineer in 1919, and I continued there until 1926. The Elliot & Harmon Engineering Company were consulting drainage engineers in part and also in flood control and reclamation. I am familiar with "Who's Who in Engineering", which is a directory of some 18 or 20 thousand engineers in the United States. The biographical and business data in those sketches [fol. 1353] is furnished by the engineers listed and is corrected and proof-read by them. The senior member of our firm was Charles Gleason Elliot, who had been a drainage engineer with the U. S. Department of Agriculture for some years before he started this firm. In the sketch under Mr.

Elliot's name in "Who's Who in Engineering" for 1925 there is included the statement, "Elliot & Harmon Engineering Company, Consulting Drainage Engineers". That truthfully stated to the public the business of the Elliot & Harmon Engineering Company in part but not in total. I think Mr. Elliot omitted or concealed something in his biographical statement to the public about his engineering qualifications. That states that it is a drainage engineering practice. In explanation, the practice of drainage engineering as handled by the concern with which I was connected, with Mr. Elliot as our consulting engineer, covered the entire field of drainage and flood control by levees, spillways, pumps and dams, reclaiming lands for agricultural uses.

I never constructed any reservoirs personally for power, for flood control or for any other purpose. I was not a power engineer. I did not construct a reservoir for flood control or any other purpose.

In 1926 I went with the Lesser Goldman & Company of St. Louis. They owned some forty to fifty thousand acres of swamp land in Arkansas and were developing it, draining it and selling it and trying to get rid of it to the public. They were trying to sell it to people in 40 and 80 acre lots. I was down there in charge of this development and promotional enterprise. As a part of my duties, what I did was to try to make sales and collect rents and generally manage this enterprise in the promotion and sale of 50,000 acres of timber and swamp land. That land was located in part in the valley of the Cache River and some of it was [fol. 1354] in other parts of the state. The Cache River is a tributary of the White River and the White is a tributary of the Mississippi. My business was trying to get people to come in and agree to buy the land on a contract in return for clearing the timber. That was a part of the terms of the contract. As a part of my activity, if they fell down on cutting the timber, we took the land back and started over again. That was in a drainage district. There was a local drainage district on some of this river. Most of the land was in a drainage district. Most of the facilities in connection with that drainage district had not been constructed before I went there; some additional facilities were constructed after I went there. All the works of the Village Creek Drainage District was constructed after I went there. All of the drainage districts on the Cache River were con-

structed before I went there. As to the most important drainage district, the bond issue of the Village Creek drainage district was about the same as the bond issue for the Cache.

"Q. Each bond issue went bad, or both of them, didn't they have trouble with both?

Mr. Fitts: We object to that, to shorten this thing.

Judge Allen: Objection sustained.

Mr. R. T. Jackson: Exception, please."

In 1934 and 1935 I was engaged in an activity which I neglected to state. That is, I was then in charge of the refuges for migratory birds. I will describe it. The U. S. Department of Agriculture through the Bureau of Agricultural Engineering which I had been connected with for some years in the past, as a survey engineer, put in some water structures on some of the water fowl refuges in the Mississippi Valley, and some in Missouri, Illinois, Arkansas and Louisiana. My work consisted in making surveys and [fol. 1355] plans and supervising the construction of water control works. At the same time I was in the employ of the Lesser Goldman Company. I finished up their work. In 1935 I entered the employ of the TVA and at the same time I was in the employ of the Lesser Goldman Company under a continuing contract which I finished in the last two months of 1935. The migratory wild fowl business did not have anything to do with flood control, except it controlled the water of the rivers and streams that came through the refuges to conserve the water for birds to light on in their flights in dry times.

With reference to Defendants' Exhibit 91, there are 20,000,000 acres in the alluvial valley. I got that figure from reading the reports of the Army Engineers. 12,000,000 acres were planned to be protected by the works adopted by the Army Engineers and by Congress. I also got that from reading the report of the Army Engineers. I included in the figure for land unprotected from floods the land between the main levees on each side of the Mississippi. The land between the main levees has no flood protection. I did not include the land in the channel of the main stream. I would hardly expect land between the levees along the main stream to be protected against flood. I would not make that mistake. I included practically all the land in my estimate

of land not protected, which was above Memphis on the east side of the river and south of Cairo, where the flood plane is too narrow to make it economically feasible to construct a levee. I also included in the land not protected, the land below Natchez where the similar flood plane is too narrow to make it economically feasible to provide flood protection. I did not include in the land which I estimated was without flood protection, the land lying in the flood-[fol. 1356] ways. I did not include the floodways in the 12,000,000 acres. I designated the floodways as being partially protected. The backwater areas I designated specifically as backwater areas. All of that land in a state of nature was subject regularly to overflow.

As I recollect, it is a fact that at the crest of the 1937 flood on the Mississippi River near Arkansas City, a flow of approximately 2,150,000 second feet was carried in the river at a gauge height of 54 feet, whereas in 1929 no more than 1,450,000 second feet were carried at the same gauge height. I could not remember those figures exactly. Throughout the Vicksburg district during the 1937 flood, the flows were relatively lower than for the same discharges in previous floods. The stages were relatively lower. At Vicksburg during the 1937 flood, the rising branch of the rating curve was improved in the carrying capacity of the river since the 1929 flood. I do not know the exact amount of improvement but it was substantial. I do not think the figures for that improvement of approximately 370,000 second feet for stages at and above 45 feet are out of line. It is also a fact that during the 1937 flood the minimum freeboard on levees in the Vicksburg district was 6 feet at the crest of the flood, ranging up to 12 feet, throughout a considerable part of that section of the river. The White and Arkansas, which very often put a peak in this part of the river, did not have a flood in 1937, so it was only the upper river that had to be taken care of. That stage was considerably lower than the stage with corresponding flows in previous years, such as 1929. That was not brought about because of any lesser flood in the White or Arkansas River floods. For the same discharge the stage was lower in 1937 than it was in 1929.

I am familiar with the work which has been done by the Corps of Engineers and the Mississippi River Commission on the Mississippi River below Memphis in the way of increasing the discharge capacity of the river by making

[fol. 1357] cut-offs. Those cut-offs start below Helena. Helena is below Memphis. It is a fact that as a result of making those cut-offs below Helena, about the mouth of the White, the stages were lower in 1937 than for corresponding discharges in earlier years. As to whether these cut-offs, when made, have increased the freeboard on the levees very much in excess of that which might be provided with the best of luck in holding back water in the TVA reservoirs, for floods of the magnitude experienced in 1937, the cut-offs reduced the stage as much or probably more than the TVA reservoirs could reduce it. In additional explanation of that point, if floods are greater, the effect of those cut-offs is not generally considered to be as effective as for a flood the size of that in 1937. When the great floods came in the past, water cut across these bends anyhow, and in that way obtained the relief that the cut-off gave, only at a higher stage. With the floods that get much higher than the flood of 1937, the cut-off effect of the water going across the bends would be there in addition to the artificial cut-offs, and it is generally considered that the effect of the cut-offs is not going to be so pronounced for greater floods. It is a reasonable estimate at Vicksburg, for instance, that these cut-offs had increased the carrying capacity of the stages above 45 feet, approximately 370,000 cubic feet per second, but up until this time we did not know, it had not been tried. I do not know that the carrying capacity of flood water below that stage has been changed, but getting above that stage the rating curves might tend to come back toward each other. I do not know it to be a fact that the effect of those cut-offs, both at Vicksburg and below, in the low and high stages, was that they worked out equally well in both stages. I don't know a thing about those experiments. I know that they have had them.

I am familiar with the fact that it is now proposed to [fol. 1358] extend these cut-off operations so as to cover the section of the Mississippi River between Cairo and Memphis at an estimated cost of only about \$15,000,000, but the difficulty is that there is not the opportunity to shorten the river between Helena and Cairo that there is below Helena. The river is straighter. There are only a few opportunities of straightening the river in that section and the percentage of reduction of the length will be very much smaller than in the section we have been discussing. I have been to

Slough Landing Neck and there is an opportunity to shorten the river there. That is the one big cut-off from Cairo to Memphis and it would have a material effect from Slough Landing Neck up towards Cairo, but not down toward Memphis. From there up to Cairo will be where it would get some benefit.

Prior to 1928, flood protection work on the Mississippi River was carried on through the cooperation of the Federal Government, the Mississippi River Commission and local interests, such as levee districts, which were required to make a certain contribution toward the construction of levees in their locality. In many cases, through either inability or unwillingness of local levee districts to finance their own protection, levees were not up to project grade and were not completed, so that there was throughout the Mississippi an uncoordinated system of levees varying in height in relation to project grade, in accordance with the degree of cooperation supplied by local levee districts, states or other local agencies. The 1914 grade of the Mississippi River Commission was entirely inadequate, even if completed, for the 1927 flood. As to whether I understood that I had been asked to express an opinion on the adequacy of the 1914 grade for the 1927 flood, my statement was in explanation of my answer.

The estimates of damages from floods in the alluvial valley which I gave were taken from the estimates of the U. S. Weather Bureau which were for floods occurring in 1927. I [fol. 1359] gave no estimate since 1927. In 1928 the Corps of Engineers and the Mississippi River Commission took over the matter of providing levees and facilities for flood protection on the Mississippi River under the 1928 Flood Control Act, which adopted the Jadwin Plan. The Jadwin Plan was a Federal Plan independent of any local contribution as far as the main stream was concerned. It was later modified by the Markham Plan. Since 1928 the Engineers have proceeded with the construction of those plans and they have not been entirely completed. For instance, in 1937, the New Madrid-Birds Point Spillway levee had not been lowered, the fuse-plug levee had not been cut down. As a matter of fact, when I said it broke, the Corps of Engineers had dynamited it in part in order to make the outlet that was desired. The fuse-plug levee failed at one place a few hours ahead of the dynamite.

"Q. And since the Corps of Engineers took over exclusive control of the levees and flood protection facilities on the Mississippi River, even though they have not yet completed their project, every flood, including the 1937 flood, has been handled by them, has it not?"

A. There were some breaks in 1937—at Slough Landing Neck. The levees at Cairo had to be sandbagged and raised two or three feet, and that levee was presumed to be completed. The levee at Hickman was presumed to be completed and it had to be raised. The back protection levee on the Bird's Point New Madrid floodway was completed or presumed to be completed; and it had to be raised in order to avoid failure this year.

Q. Did the back levee fail in 1937?

A. No, they raised it so it did not fail.

Q. Don't you know that the Slough Neck Levee was supposed to be overtopped under the Jadwin Plan?

A. It was a small levee.

Q. Don't you know it was supposed to be overtopped?

A. Yes, I think it was.

Q. Then why did you say that it did not handle it because the levee was overtopped?

A. Well, I described that along with the others.

[fol. 1360] Q. Do you mean to say you were describing failures in the plan of the Army Engineers because it operated as it was designed to operate?

A. I did not say it was a failure of the plan. It was a failure of the levee.

Q. The levee was designed to be overtopped?

A. Yes, and it failed.

Q. And what happened was just what was designed to happen?

A. It failed just as it was intended to."

I do not know how many miles of railroad in the alluvial valley were protected during the 1937 flood on the Mississippi. All the railroads in the valley will be protected when the presently projected works of the Mississippi River Commission are completed—as long as the water does not overtop the levees. The 1937 flood demonstrated that the levees from Cairo down are not high enough for a flood that should be protected against. It would affect it from Cairo to the mouth of the White River. At the height of the flood in 1937, my recollection is that there were four or five feet of

freeboard on the levees at the town of New Madrid. That was enough freeboard for that flood, but that flood is not the maximum flood anticipated which should be provided against.

I don't know the mileage but most of the highways in the alluvial valley were protected during the 1937 flood. I don't know the exact population in the alluvial valley which was protected during the 1937 flood, but most of the land was not flooded. As to whether most of the population was protected that word, "protection" is relative. About 300,000 people were so concerned about the 1937 flood that they fled out of that valley. The Red Cross figures show that they cared for 70,000 families below Cairo. Those people were so concerned about the safety of that levee that they left their homes. I don't know anything about whether that was due to the false radio report that was sent out. It was due to the fact that the water was going to be several feet higher [fol. 1361] than it ever had been before and they did not trust the levees and left their homes. I don't know the mileage of the telephone and telegraph lines in the alluvial valley that were protected during the 1937 flood but most of them were protected. I do not know how many post-offices were inundated in the alluvial valley in 1937. I do know of some. The backwater got in the town of Hughes, Arkansas, and some of those towns down the line. Hughes is on the lower end of the St. Francis Basin, thirty miles southwest of Memphis.

As to what percentage of the U. S. cotton crop in 1937 was destroyed by the 1937 flood on the Mississippi, the 1937 flood came in January and February and at that time no part of the cotton crop was in the field, or very little. The short answer is not that there was none because there was still some cotton in the field up at Birds Point-New Madrid, and still some cotton in the fields in the backwater areas which was not out yet, but I have not figured out what percentage that was. As to whether in my studies I learned that the 1937 cotton crop was the largest in the history of the United States, I read in the newspapers that the 1937 crop was a big crop of cotton. In my study of this problem I made no calculation of how much it would cost the Federal Government to pay people for not growing cotton on this other land if this additional 8,000,000 acres were protected.

I am familiar with the Jadwin Plan as presently modified for Mississippi protection. The 1937 flood was confined as

contemplated in the so-called Jadwin Plan from Cairo to the Gulf, but at a higher stage for the discharge involved. It was not confined as contemplated in that it got higher than the plan contemplated for the same discharge. From the White and Arkansas Rivers down, the stage in the 1937 flood was lower for the same discharge than previously experienced. As to whether the modified Jadwin Plan would [fol. 1362] have safely carried the flood water of 1912, 1913 and 1927 to the gulf as it did the flood water of 1937, in the present state of construction of the Jadwin Plan, I think the 1927 flood, if repeated, would have broken the levees below the White and the Arkansas River on the right descending bank, because they have not been raised since 1927 at all where the reach for the Boeuf spillway and the Eudora spillway are to take off, and I think the levee on the west side there would have failed. That is right there where there is supposed to be a floodway. The Jadwin Plan contemplates in the time of very large floods that the spillways will be used, but I said in the present stage of completion it would have failed there. There is no floodway there now. I mean the floodway is not yet completed.

On the Bird's Point-New Madrid floodway the Federal Government has purchased flowage rights. I believe they estimate that that might be flooded once in ten years and the Federal Government has paid for the right to flood it once in ten years. As to whether the present Jadwin-Markham Plan provides similarly for the purchase of flowage rights and fees in other floodways, the last recommendation of the Chief of Engineers was that because of the bitter experience in the great destruction of property and risk of life in the Bird's Point-New Madrid floodway this last January, they are recommending the purchase of the fee in those other floodways down the river. But there was no recommendation now to go back and purchase the fee at Bird's Point-New Madrid. They have purchased the flowage rights, but that did not keep the people from staying there and cultivating it just as though they had not purchased flowage rights. I don't know whether there was any loss of life in the Bird's Point-New Madrid floodway. There were some narrow escapes. I was there a week after the thing broke and talked to the people. As to the total damage from flooding the Bird's Point-New Madrid floodway after the crop season ranging between \$1,500,000 and \$2,000,000 once in [fol. 1363] 10 to 12 years, I think the loss was slightly over

\$2,000,000 this year. I got that information partly from my own work and from some other employees of the U. S. Department of Agriculture and of the TVA. I was in there and looked at some of that territory. I did not get it out of any official report. It was based on some sample observations taken after the flood went down. If it was flooded once every ten years, the average annual damage on that basis would be \$200,000, for which the owners of the land had been paid when the Federal Government purchased the flowage rights.

"Q. Now, Mr. Okey, did the discharge of the Mississippi River at Cairo exceed the estimated maximum discharge under the Jadwin Plan in 1937?

A. No, but for the discharge they had it got higher than they expected it would.

Q. Isn't it a fact that while the Ohio River discharge was higher than expected the Mississippi River discharge was not?

A. Fortunately there was a very small flood on the Mississippi River. If they had a moderate flow or an ordinary flow on the Mississippi it would have meant disaster.

Q. Fortunately or unfortunately, which I happened not to ask you about, the fact is that the flow of the Mississippi at Cairo did not exceed the predicted flow, isn't that right?

A. The discharge in the 1937 flood was less than the discharge predicted in the Jadwin Plan."

I have stated in my opinion it is necessary for the protection of the levees to reduce the stages by 2 feet. So far as the levee system is concerned, a reduction in the stages by two feet could be achieved by raising the levees to give an equivalent protection to the system. If you could raise the levees and make them stay there, that would give the same margin, but the trouble is that the levees are up to their practicable limit of height and some of them are subsiding now. I never built any of those levees along the Mississippi River. I never worked for the Mississippi River Commission. I base my opinion that the levees cannot be raised 2 feet or more, first, on my personal observation of [fol. 1364] seeing the levees subside, and, second, on the statement by the Mississippi River Commission engineers and the United States Army Chief of Engineers in official reports, which state that the levees are as high as they can

build them or are approaching the safe limits. They don't want to raise them any higher. I wouldn't say I principally base my statement on what I have read in these reports. I have been up and down those levees since 1909 and observed the spots where the levees subsided and had to be raised again and subsequently raised again. I was not in charge of any of those levees from 1909 on, but I have lived in the valley and have been up and down those levees during all the high waters.

It is my opinion that the levee at Cairo can be raised, but the character of the sub-soil material on which that levee rests is such that the additional height of the levee would not give any greater security. In the flood last winter they had tremendous sand boils inside of the levee and the raising of the levee would not help the sand boils at all. In the report which I have studied, Committee Document No. 1, 75th Congress, First Session, page 5, the Chief of Engineers says:

"The River wall at Cairo, which was temporarily built up in advance of the recent flood, should be raised to afford permanent protection."

As to whether it is my opinion that the recommendation of the Chief of Engineers is impracticable or could not be carried out, the levee could be raised at Cairo. Assuming that the stage at Cairo is reduced in some fashion by two feet at the time of the great flood, I do not expect the same reduction at New Madrid, Memphis, Vicksburg and New Orleans. The reduction would be practically uniform from Cairo down to the mouth of the White River; from the mouth of the White on down, the reduction in stage would be less. I cannot tell whether the statement I made, that a reduction of two feet would reduce the amount of area of flooded land by 100,000 acres, was based on a two foot reduction through-[fol. 1365] out the entire valley without referring to my notes. That two foot reduction covers the entire river, so that that figure would be inaccurate as to the effect of the two foot reduction in stage at Cairo alone. The reduction would continue down to the White River, which is about 400 miles down, about opposite Greenville, Mississippi.

I am familiar in a general way with the gauge relationship between Cairo and New Madrid. It is my testimony that a reduction in the gauge height of two feet at Cairo

will be reflected in a reduction of approximately two feet at New Madrid. As to whether I know the records show that a reduction of two feet at Cairo will be reflected only in a reduction of a foot and a half at New Madrid, if I recall it is about two feet. At some points along the river there are some variations, but the average is about two feet. Different floods give different stages and the relation between the gauges is not always constant. I do not know whether or not in the model studies it has been tried out. As to when the reduction of two feet at Cairo results in a reduction of more than two feet at New Madrid and when it will result in less, in the past the relation between those gauges has varied somewhat, taking the past floods' higher and lower stages at New Madrid. It is not constant. I do not remember what the figures for the flood stage at Cairo and the corresponding flood stages at New Madrid were during the 1937 flood. I have the working papers of the Mississippi River and the stage at Cairo was at the highest 59.62 and at New Madrid was 47.97. I do not know what the corresponding bank-full stages are at those two places. I do not know that the bank-full stage is 42 feet at Cairo and 34 feet at New Madrid. I could not remember that. I testified that a reduction of 2 feet in stage at Cairo would reduce the frequency of operation of these floodways. If the levee system were raised by the amount necessary to make it safe for the predicted flood, the flood section levees could be raised so as to reduce the frequency of the use of the floodways by the same amount as would be obtained by the reduction in stage at Cairo. If the levees would stay up there after they built them, that could be accomplished that way. If the effect of reducing the flood crest at Cairo by two feet was less at the other floodways further down stream, the frequency of operation of those lower floodways would not be reduced as much as I estimated for a two foot reduction at Cairo. My estimate was based on a two foot reduction all the way down the river regardless of how it was accomplished, even though it was accomplished by cut-offs. It would not make any difference how it was lowered. My study was based on what the effect of lowering would be, rather than how it could be lowered.

I am familiar with the backwater conditions in the Mississippi Valley. As to whether it is not true that the backwater stages frequently lag several days or a week or more behind the crest stages on the main river, and are frequently

lower than the main river stages when there is little inflow from the tributaries, under those conditions the water runs around the end of the levee and fills the backwater area, and that lagging is only a few days and a few inches, but if the flood stays up very long it levels up. It would not have to stay up but a few days. When there is a large inflow from the tributaries, the stages are higher in the backwater areas than they are on the main river. The lake in the backwater areas is tipped up a little by the inflow from the tributaries. Those two conditions sort of even up. Whether it is true in a flood of long duration that the backwater stages on the floodways are higher for the same maximum river stage than for a flood of short duration would depend on the inflow from the tributaries at that point. It might modify it. Assuming the same conditions as to inflow in both cases, [fol. 1367] it would be a little higher in a long flood than in a short flood. If you take two feet off the crest of a flood lasting perhaps a day or a day and half on the Mississippi, it is my testimony that there would be reflected a corresponding reduction in backwater overflow. The only thing in your assumption of a crest on the Mississippi of only a day or two is an impossible condition. It does not do that, the flood stays up longer than that. The flood itself does last many weeks, but the water stays within a foot or two of crest stage for several days. It rises and falls slowly on that giant stream. It is my testimony that it is impossible to take a foot or two off of the crest of the Mississippi River flood over a period of one or two days because the crest lasts longer than a day or two. As to whether to take one or two feet off of the crest of a Mississippi River flood, you do not have to be able to take off that much water over a period of possibly weeks. Weeks is too long. Depending on the flood, 10 days or 2 weeks would probably be a fair statement of how long you would have to take it off.

To reach the annual average figure for land overflowed by backwater and also my figure for 100,000 acres of reduction in overflow of lands by reason of two foot reductions in flood crest, I made a study of the floods for the last 40 years, and with the flood stage reached in each of these areas, there would be a certain amount of land overflowed. If that flood is reduced by two feet for that particular year, there would be a less amount of land overflowed, and the determination was made similarly for the balance of the 40 years on that figure I gave, which was the average for that

period. I examined the scale for each year for a period of over 40 years, and made a computation for each year. Then I added them up and divided them by the number of years. The Mississippi River Commission has worked out some area elevation curves for each of the backwater areas and [fol. 1368] each of the unprotected areas for each state which is flooded. What I did was to take some curves prepared by the Mississippi River Commission and read the figures off of those and check it in a general way with certain elevations of the topographical map by planimeter work. That is the U. S. Geological survey maps. The backwater areas contain only a small percentage of sloughs and swamps, it is mostly good land, and it is well drained when the river is down. It is mostly cut-over timber land.

I said I had never had charge of any levee construction on the Mississippi River. It is difficult for me to make an estimate of how many miles of levees I have examined under construction. I have been on the river off and on for the last 28 years, seeing the construction work and seeing the finished levees, some hundreds of miles perhaps. I was not working on the levees. As to whether I did examine some hundreds of miles of levees, in the course of my engineering practice, I was through that country frequently and the levee was the most important object with all those people. We kept in touch with the work.

I am familiar with the matter of seepage through and under the levees. It is true that it requires a long and continued high stage of the river to produce an appreciable amount of seepage. When the Mississippi River gets very high, they have seepage. A reduction of the crest stage for a relatively short time during a long continued major flood would have an important effect in reducing the volume of the seepage. The natural law for determining the amount of seepage through levees and under the foundations is that the greater the hydraulic pressure on the permeable strata that underlie a levee, the greater the distance behind the levee the seepage extends. That law has no name, it is just this simple law that water seeks its level. The scientific formula that is applicable is that water seeks its own level. That is the basis of the formula that I, as an engineer, used in making my engineering computations. [fol. 1369] I do not know the name of the formula that does govern. I cannot give you the name of any formula

except the basis is that the pressure of the water forces the water out through the sand and it comes up in the fields. It is not right to say that after all my expert testimony about seepage, all I know is that the water seeks its own level. The amount of seepage in those fields can be observed and measured, and in great floods there is lots more land affected by seepage than in lower floods, so it is a question of actual observation and not theoretical computation. All I am testifying about is a matter of observing the water in those fields.

As an engineer, I know how to compute what, if any, seepage could occur at a levee at a given place. I could go into that theoretically. I can't tell the formula offhand, it is too complicated. I think I have heard of D'Arcy's Law. As to whether it was LaFayette's Law instead of D'Arcy's, I am not arguing with you on that point. I have heard of D'Arcy's Law. I cannot remember what it has to do with. It would not mean a thing to me to know that that formula is $Q=KIAT$. As a matter of fact I don't know whether that is the formula for computing the extent of seepage under a levee or not. I could not qualify on that formula for computing the extent of seepage through or under a levee. My testimony was based on observations of what happened when the water got up there. I only made observations in a general way of the difference with the stage two feet lower. I know this, I have been up and down those levees all these years, and when the floods get higher the seepage is greater, and when the floods are not so high the seepage is not so great. As to whether it is a fact that in that formula which determines the question of seepage, Q is the quantity of flow, K is the co-efficient of [fol. 1370] permeability in the material, A is the area through which the flow takes place, T is the time of duration of the head and I is the head, I stated a moment ago, I could not qualify on the details of that formula. Your recitation of it sounds reasonable. As to whether, as far as I know, it might be that or something else, as I say, I did not qualify on that formula. My testimony on seepage is not based on that or any other formula. It is a fact that engineers who actually build levees and make responsible estimates with reference to such things have to know such formulas to make such computations. An engineer

could assume responsibility for building a levee and in determining its safety as to the question of seepage without a knowledge of such a formula and without making such computations. He could base it on experience and that is what most of the levee building is based on on the Mississippi, without considering this theoretical computation. They must build the levees wherever they can build them.

In that formula if you reduce the stage for a short period at the crest, you would affect the factor of head only and everything else would remain the same. As you recited it to me that is the only factor you would affect in that law. Flood stage is generally about bank level. The duration of the flood stage upon the Mississippi River varies from a month to two months. During the average great flood, the average stage against the levee above the surrounding land might be in certain sections of the levee as much as 15 feet. If you took 2 feet off the stage and reduce it to 13 feet and you reduce that for, say, ten days or two weeks according to my previous testimony—I could not make the computation with the data you have given me that such a reduction for ten days would have reduced the seepage by perhaps $1/25$ th. I would not either accept or deny the correctness of that computation. I still think that if you [fol. 1371] reduce the stage two feet for ten days or two weeks out of a month, you would materially affect the seepage through or under a levee. I am still clear on that. But I don't know how to compute it. We watch what happens by observation. I think a reduction of $1/25$ th of the total amount of water that seeps through would be a substantial reduction. I did not have in mind a reduction of $1/25$ th. As to how much percentage I did have in mind, my figures were based on area and I don't remember making a percentage computation based on the acres less which were affected.

I said I have seen hundreds of miles of levees built or under construction. I have seen maybe 100 or 200 miles of levees under construction. If I also said that these levees are largely built on sand and gravel, that is my testimony. I now say it is the truth that these levees are underlaid by sand and gravel. I know that by observing the one hundred miles that I saw under construction and by seeing the character of the land along the river bank where the river has cut down so I can see what is under-

neath, and in that way I can say that the hundreds of miles of levees along the Mississippi River are underlaid by sand and gravel. I do not want to create the impression that the sand and gravel is on top of the ground, but they are underlaid by sand and gravel, the deeper strata are very often sand and gravel. It is not my observation that levees built on sand and gravel sink. They do not sink ordinarily and that is what most of them are built on.

My testimony that the reduction in stage of 2 feet at Cairo would reduce the cost of high water fighting by an amount averaging \$225,000 annually was based upon past experience, not my experience, but experience on the river. If I may explain, at each time of high water money is expended by the various governmental and state agencies for high water expenses on the levees, and the Mississippi River Commission has kept data on how much they spent [fol. 1372] on each high water and the various levee districts up and down the river have kept account of their expenses. My testimony was based on the average experience of the high water expense for the last 40 years. I took some figures that I had gotten from the Mississippi River Commission and some from other public authorities and they are the official figures that those agencies had spent on the river. The \$225,000 was taken not by observation. That was by computation. The expense for the floods when the river became very high was much greater than when the floods were lower, and the reduction of two feet would show a less expense of high water maintenance. My figure is based on the past experience of about 40 years of high water expense on the river. The average experience shows that for each foot of gauge height increase, after you get up into the flood stages, the annual expense increased about \$100,000 per foot per year, and two feet less would be a \$200,000 annual reduction. Most of these costs in the past were for general high water expense, in part where the levees were not up to the project grade at the particular place. That was a condition which is reflected in this whole situation which I told about where various levee districts were partially responsible for levees in their own localities and either were unwilling or unable to finance raising them to project level, but the greatest expense on the levee system for high water fighting in any

1940

one year was expended in 1937, after these levees had been brought to the higher stages. I never personally had anything to do with nor had charge of maintaining these levees.

(The witness was excused.)

[fol. 1373] C. T. BARKER was called as a witness on behalf of the defendants and, having been first duly sworn, was examined and testified as follows:

Direct examination:

I am 39 years old, reside in Knoxville, Tennessee, and am a hydraulic engineer. I graduated from the University of Minnesota in 1922. For one year and three months immediately following graduation I served as contractor's engineer on a hydraulic project where hydraulic sluicing was the principal engineering problem. From April, 1924, to April, 1928, I was engaged in the investigation of navigation, flood control and hydro-electric problems in preparation of House Document 328, 71st Congress, Second Session, with the United States Engineering Department at Chattanooga, Tennessee. This time was divided about as follows: junior draftsman on hydraulic exhibits, six months; computer and designer on navigation, flood control and hydro-electric structures, one year; first assistant to the Head Engineer in charge of the preparation of all hydraulic, hydrographic and preliminary design data entering into a complete analysis of the water resources of the Tennessee River Basin as applied to navigation, flood control and hydro-electric power production, 2½ years.

From May, 1928, to August, 1932, I was engaged in the preparation of reports authorized by Congress in accordance with House Document 308, 69th Congress, First Session, with the United States Engineer Department, Kansas City, Missouri. This time was divided about as follows: area engineer on Platte River in charge of all field surveys necessary for the study of the water resources of the Platte River Basin, one year; assistant to the chief of the Flood Control Division and in direct charge of the design of flood control projects and the preparation of reports dealing with flood control, irrigation, navigation and water prob-

[fol. 1374] lems on the Mississippi River and its principal tributaries, three years and three months.

From September, 1932, to March, 1933, I was engineer in charge of the U. S. Engineer Office at Sioux City, Iowa, supervising the construction of navigation improvements on the Missouri River at Sioux City and Omaha, Nebraska. From April, 1933, to November, 1933, I was engineer in charge of the hydraulic and civil engineering section of the U. S. Engineer Department at Wilson Dam at Florence, Alabama, and was responsible for the preparation of studies and reports on hydraulic problems, hydrographic surveys, and improvements in navigation on the Tennessee River from Hales Bar to Riverton, Alabama. From December, 1933, until now, I have been engineer in charge of the navigation section of the TVA engaged in the study and preparation of reports on the navigation problems on the Tennessee River.

I was with the Army Engineers from 1924 to 1928 studying all phases of navigation on the Tennessee River and its tributaries. I was also engaged by the Army Engineers in 1933 in charge of navigation improvements between Hales Bar and Riverton, about one-third of the river, and I have been with the TVA on navigation problems for four years. About a year and one-half or two years ago I had prepared a complete list of official surveys and reports which I have studied and referred to pertaining to the Tennessee River. I have studied practically all of these reports except some of the very earliest that were not available. I have studied excerpts in the Chief of Engineer's reports in those earlier years also.

The map (offered and received in evidence as Defendants' Exhibit 92) shows the condition of the Tennessee River before the creation of the TVA as of May, 1933.

It shows the geographical position of the Tennessee River, its course from its formation by the junction of the Holston and French Broad Rivers just above Knoxville [fol. 1375] to its mouth at Paducah, Kentucky, and its principal navigable tributaries, which, starting on the north side of the river and including the tributary furthest down stream, consist of the Duck, Elk, Sequatchie, Clinch-Powell system, the Holston, French Broad, Little Tennessee, and Hiwassee Rivers.

Examination by the Court:

The Emory River is not shown. It comes through Hariman, Tennessee, just to the left of Knoxville, and goes into the Clinch River just above the junction of the Clinch with the Tennessee, a considerable distance below the Powell River. The Emory River is not listed as navigable. (The date, May 18, 1933, the Wheeler Lock and the Emory River were subsequently placed upon the exhibit by the defendants.)

Direct examination continued:

The map (offered and received in evidence as Defendants' Exhibit 93) is entitled "Profile of the Tennessee River Improvement," and shows a profile of the Tennessee River in its unimproved condition before any locks and dams had created slack water pools. On the upper right hand side is Knoxville at an elevation of a little higher than 800. The river then slopes downward towards the left hand side of the chart, passing Chattanooga and Hales Bar, with a very steep portion about in the middle which is Muscle Shoals rapids. There is another slightly less steep place at the left of that point, which is Colbert Shoals rapids, and the profile continues on to the mouth of the river at Paducah, Kentucky. It shows there is a considerable variation in the slope throughout the natural channel of the river. The average slope between Knoxville and Hales Bar is about one foot per mile; between Hales Bar and Brown's Island, about .4 of 1 foot per mile; between Brown's Island and Florence, about 3.6 feet per mile; be-[fol. 1376] tween Florence and the head of Colbert Shoals, about .6 of 1 foot per mile; and between the foot of Colbert Shoals and Paducah about .34 of 1 foot per mile. That variation in slope has an effect upon navigation conditions and the type of navigation improvement that is possible. The river in its unimproved condition, having great variation in slope, would cause great variation in channel depth and channel velocities and would make the river very difficult to navigate, and practically impossible to navigate in certain sections unless substantial improvements were accomplished. There are a large number of obstructions shown by name over on the left hand side of the exhibit, including the Big Bend Shoals, Colbert Shoals, Tuscumbia Bar and Muscle Shoals, which are only some of the impor-

tant bars and rapids, which are obstructions to navigation in the improvement of the river. In my opinion no satisfactory navigation channel could be obtained through the entire length of the Tennessee River in view of those conditions, without the construction of dams of some character.

The table (offered and received in evidence as Defendants' Exhibit 94) is headed "Maximum and Minimum Rates of Stream Flow, Tennessee River." These great variations in stream flow also cause great variations in channel depth and velocities, and a navigator would have a hard time predicting just what amount of stream flow he might encounter from time to time, and would also have trouble in determining what depth of channel he could count on. He would also be concerned with the great variations in velocity of the unimproved river and with these variations in stream flow.

The map (offered and received in evidence as Defendants' Exhibit 95) is entitled "Previous Projects Tennessee River Basin." The title is explanatory of what the map purports to show, which are the projects previous to the [fol. 1377] 9 ft. channel project. The heading on the right hand corner of the exhibit shows the navigation projects on the Tennessee River and principal tributaries, and shows them with the dates as adopted by Congress prior to the Rivers and Harbors Act of 1930. The table on Defendants' Exhibit 95 shows the previous projects listed by dates from 1852 to 1925. About 12 of the 18 projects listed there were for open channel development without locks and dams, which are referred to as "O. C." Three were for canalized projects with locks and dams, either entirely across the river or partially across the river, such as Elk River, Muscle Shoals Canals, Colbert Shoals Canal, Riverton Lock and Florence Canal, with Lock and Dam No. 1. Then there are slack water developments noted by the symbol "S. W.," with dams entirely across the river providing slack water pools, such as Wilson Dam, the Caney Forks Creek pool and the Hales Bar lock and dam. The lower part of the tabulation shows the total expenditures on the main stream to June 30, 1935, as \$25,297,468.03. The figures given on the map refer to the mileage of the particular point upon the river above the mouth of the river. Knoxville is 647 miles and Kelly's Ferry is 442 miles from Paducah. The

1944

figure of \$25,297,468.03 for the total cost is purely for navigation projects and excludes Wilson Dam, Lake and power house.

Cross-examination:

As to whether the figure includes all maintenance and operations, I can look that up. When I compiled that figure, I took it to be capital expenditures.

In the lower part of the table on the left hand side of the chart, there is a list of the projects for tributary improvement.

(Thereupon the Court stated that the figure on the exhibit for the expenditures ought to be amended to show "Exclusive of Wilson Dam," which was subsequently done.)

[fol. 1378] Direct examination continued:

The chart (offered in evidence as Defendants' Exhibit 96, withdrawn for correction and later received in evidence as corrected) is entitled "Commerce on the Tennessee River". I would like to make a slight change in the plotting of the years 1930 to 1935. The tonnages are correctly shown, but the artist in drawing that line got about a half of one of these small spaces to the right, so that a slight correction there would help; but in general it shows the correct tonnages.

"Mr. R. T. Jackson: I object to the legend in that it says, 'Tons of freight moved on the Tennessee River, 1892 to 1933.' Those statistics are always a year late, and the ones for 1936 are not yet available, not yet published, and it seems to me to be in error to that extent, that it is a year ahead."

The figures are as reported in the Annual Reports of the Chief of Engineers. For example, the figures for 1936 show the commerce up to July of 1936, and this Report comes out in July.

Cross-examination:

I think it is correct that the reports are for the calendar year.

Direct examination continued:

On checking my table here, I see that the figures were taken from the Annual Reports of the Chief of Engineers from 1892 to 1936. The tonnages would be for the calendar year set back one year, that is, 1935 would be the calendar year shown. I do not purport to show anything for the calendar year 1936.

"Mr. R. T. Jackson: We object because inadvertently the whole graph is misleading because it is shoved ahead on the time scale from what it should be. It actually shows the calendar years 1892 to 1935, inclusive."

Examination by the Court:

That is not up to July, 1936, I think I misstated that. It stops at January 1, 1936, that is my understanding of the figures as they are shown in the Chief's report.

[fol. 1379] "Mr. R. T. Jackson: The result is that for every year the information is six months too far ahead.

Judge Allen: The Court suggests that this legend read 'Up to January 1, 1936.'

Mr. R. T. Jackson: If your Honors please, we object to it because it is misleading then, because, for instance what it shows for the peak in 1900 is not in 1900. That is the middle of the year before, and the whole thing has been shoved six months ahead.

Judge Gore: Does it begin in July, 1892, or January 1, 1892? The graph would show the middle of 1892.

Mr. R. T. Jackson: It should begin January 1, 1892.

Judge Gore: It looks like it might begin here in the middle of 1892.

Mr. R. T. Jackson: But the difficulty is that the statistics of the Chief of Engineers are published by calendar years, and they could not begin at that time. It has to begin with the first of January, and end with the 31st of December, so I take it that what Mr. Barker has inadvertently done, or his draftsmen, is to shove his whole graph six months ahead of what it should be. The first line should start at the extreme left hand vertical line under 1892, and the last should start with the line 1935, and everything should be shoved back to the left.

Judge Allen: This represents groups of five years, and if the graph began at the black line furthest to the left then it would read from 1890, and not 1892.

Mr. R. T. Jackson: The only point we make is that it is all six months too far ahead.

Judge Allen: The Court suggests that this be withdrawn, and the graph indicate the precise time in 1892. It looks now as though it began in July of 1892, and also it does indicate that it goes over into 1936 on the graph."

Prior to May, 1933, the traffic on the Tennessee River consisted of sand, gravel, building stone, forest products, iron and steel, and miscellaneous manufactured articles which moved mostly by short stretches and there was not a great deal of through traffic. Short haul traffic was largely due to the partial improvement of the river and the poor channels available. Through traffic was pretty well blocked by the lack of sufficient improvement on the river.

[fol. 1380] The chart (offered and received in evidence as Defendants' Exhibit 97) is entitled "Existing and Proposed Channel Depths before TVA Act," and was prepared by me or under my supervision and direction and the facts shown on it are accurate and correct.

"Mr. Fitts: I will offer the exhibit on the standard which has just been identified in evidence as defendants' exhibit 97.

Mr. R. T. Jackson: We object to it as utterly misleading and incompetent. It says 'Existing and proposed channel depths,' and it does not show who proposed the channel depths. As a matter of fact, if the truth is brought out, it will appear that there has been a report that has suggested a possibility of certain channel depths, for instance, in certain tributaries—

Judge Allen: The legend shows that certain tributary channel depths were proposed by the Army Engineers.

Mr. Fitts: Have you looked at the explanation?

Mr. R. T. Jackson: I don't understand that they are proposed by the Army Engineers.

Mr. Fitts: That is what it says.

Mr. R. T. Jackson: I know that is what it says. That is the trouble; it is untrue.

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Mr. R. T. Jackson: It is not proposed; it does not propose anything.

Mr. Fitts: Do you want to testify on the subject?

Mr. R. T. Jackson: I don't need to, because the document is in evidence, and it shows that the legend is untrue.

Mr. Fitts: I will ask the witness to testify—

Mr. R. T. Jackson: Let me finish.

By Mr. Fitts:

Q. Mr. Barker, is the statement correct that appears on the exhibit?

Mr. R. T. Jackson: I object to the question.

Judge Allen: He may answer.

Mr. R. T. Jackson: May I state the grounds of the objection?

Judge Allen: He may answer whether it is correct.

[fol. 1381] A. I believe it is, as I read the House Document.

Judge Allen: You may have your exception.

Mr. R. T. Jackson: May I have an exception both to the ruling, and to the refusal of the Court to permit me to state the grounds on which I object to the question?

Judge Allen: The witness may testify whether the matter is correct. You may now state the grounds of your objection if you desire.

Mr. R. T. Jackson: The ground of my objection was that the question of whether or not these were authorized or adopted must depend upon the action of Congress and not upon the testimony of this witness. It is utterly incompetent for this witness to attempt to prove anything is authorized by his oral testimony, and the fact is that the evidence in the record before this Court shows that it is not true because the only thing that has been adopted by the Congress is by the Rivers and Harbors Act of July 3, 1930, which is for a low dam plan on the main Tennessee River, and nothing whatsoever on these tributaries. We will have a witness coming in here later to testify that that is correct.

Mr. Fitts: That is not what it says. All that the legend says is that the main river channel depths were adopted in the Rivers and Harbors Act of 1930. You don't dispute that?

Mr. R. T. Jackson: Just a moment. Let me finish. As far as it is proposed, it only encumbers the record with

utterly irrelevant and incompetent testimony. I can go to Congress and I can bring out hundreds of reports of proposals that have been submitted to Congress and they haven't any more significance than last year's almanac unless they have been adopted and approved by the Congress.

Judge Allen: How much of the noon hour shall we consume, Mr. Jackson?

Mr. R. T. Jackson: I want to consume only enough to make my point and make it clear to the Court, because I think it is highly prejudicial that we should have introduced in this record statements of proposals of someone that have no authority and no effect whatsoever.

Mr. Fitts: I might state that Complainants started trying this case upon the basis of the proposals in House Document 328. Now, they don't like them, they have found out more about them, and they don't like the proposals.

Mr. R. T. Jackson: We are standing squarely upon what is incorporated in the Rivers and Harbors Act of 1930. [fol. 1382] Mr. Fitts: They have offered them in evidence. They were the first to mention them in this case.

Judge Allen: The exhibit is admitted and you may have your objection.

Mr. R. T. Jackson: Exception noted.

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Judge Allen: Just a moment, Mr. Fitts. In view of the fact that Mr. Jackson was absent two days before Christmas—perhaps not two days, but a day and a half, or parts of two days—we think it well to repeat something that was said in his absence, which was this:

The Court permitted exhibits to be received in evidence which were bitterly protested by the Authority upon the ground that they presented the Complainants' Theory of the case. For that reason we allowed the purple and the red, because it presented the theory of the case, although they are not very sharply distinguishable colors.

Now, with reference to this map which the complainants have protested, we feel that this map presents, and clearly, and without misleading, reading the legend with the title, the theory of the defendants, and we think the objection goes to the competency and not to the weight."

Defendants' Exhibit 97 shows by the blue line and the blue figures, the depths of the existing channel before the

TVA Act. For example, between Paducah, Kentucky, and Riverton, Alabama, the existing channel depth was $4\frac{1}{2}$ feet at ordinary low water. Throughout Colbert Shoals canal just above Riverton, it was 7 feet. From the head of the canal at Florence, Alabama, it was 4 feet. The red lines and the red figures indicate the depth of channel along the main stream, as proposed by the Army engineers in House Document 328 and as authorized and adopted in the Rivers and Harbors Act of 1930, namely, 9 feet of depth throughout the entire length of the Tennessee River from Paducah to Knoxville.

The chart (offered and received in evidence as Defendants' Exhibit 98) is labeled "TVA Projects," and was prepared by me or under my supervision and direction and the facts shown thereon are accurate and correct.

[fol. 1383] "Mr. Fitts: We offer in evidence as Defendants' Exhibit 98 the exhibit which is now on the standard, entitled 'TVA projects'.

Mr. R. T. Jackson: We object to it because it is misleading and incomplete. It does not show the Fontana Dam Site, as set forth in the report to Congress last week or the week before last.

Mr. Fitts: We discussed that, if the Court please, just before adjournment, and the Court expressed the opinion that this statement was sufficiently amplified.

Mr. R. T. Jackson: Then if it is, it conflicts with the statement 'TVA project'. It seems to me that it is highly improper that exhibits should be offered here which contradict the reports which are being submitted to Congress at the same time.

Judge Allen: The objection is overruled, and you may have your exception.

Mr. R. T. Jackson: Exception, please."

Each of the projects shown on Defendants' Exhibit 98 is located at or near the sites, with just a little variation in some cases, which were proposed for the high dams in House Document 328. In my opinion each of the dams constructed, under construction or proposed for construction, as shown on Defendants' Exhibit 98, when constructed, will provide a substantial improvement to navigation upon the Tennessee River and will provide a navigation channel for boats with a 9 foot draft and an over depth of around 2 feet.

The most difficult section of the Tennessee River to navigate below Chattanooga, and just prior to the beginning of the TVA's projects, was that section from the head of Wilson pool up stream to the existing Widow's Bar Dam, which is in the upper portion of the Guntersville pool and about 24 miles down stream from the existing Hales Bar Dam.

Examination by the Court:

Widow's Bar Dam is not shown on this map because it will be submerged by the TVA project known as Guntersville Dam.

[fol. 1384] Direct examination continued:

That section from the head of Wilson pool to Hales Bar had a controlling depth of about 3 feet and the channel was very winding and tortuous, and quite narrow in many places. The construction of the Wheeler Dam by the TVA overcame the obstacles and extended the 9 foot channel from the upper end of Wilson pool to the vicinity of Guntersville, Alabama.

The next section that was probably the most difficult to navigate was the one between Riverton, Alabama, and Florence, Alabama, wherein the controlling depth at ordinary low water was about 4 feet, and there were many narrow, dredged cuts. The construction of Pickwick Dam by the TVA, a few miles below Riverton, overcame these obstacles and extended the 9 foot channel from Pickwick Landing upstream to the existing lock and dam No. 1, a distance of about 50 miles. The remainder of that reach below the Widow's Bar Dam will be improved for 9 foot navigation by the construction of the Guntersville Dam in the upper end of the Wheeler pool, which will extend the 9 foot channel from the upper end of the Wheeler pool all the way to Hales Bar Dam, flooding out the existing Widow's Bar Dam.

Above Chattanooga, the entire reach to Knoxville is very difficult to navigate, having a controlling depth at low water of only about 1 foot. Chickamauga Dam would be the first logical step in extending the 9 foot channel from the upper end of Hales Bar pool upstream towards Knoxville. The Chickamauga Dam itself would extend the 9 foot channel from the upper end of Hales Bar pool a distance of about

58 miles to the proposed Watts Bar site, also extending it up the Hiwassee River a distance of about 20 miles to Charleston, Tennessee.

After the construction of Pickwick Landing, Wheeler and Guntersville, but before the completion of Gilbertsville [fol. 1385] Dam, there will be a stretch of open river which will extend from the upper end of the very short pool which is created on the lower part of the Tennessee by Dam 52 on the Ohio River. That open channel will continue upstream to the Pickwick Landing Dam. With the use of releases in low water seasons from Norris and Hiwassee Dams, a channel of the depth of 7 to 7½ feet could be maintained in that open stretch of the river in the lowest water seasons. Before the construction of Gilbertsville and upon the completion of the dams under construction, there will be a minimum 7 foot channel from the Ohio to Pickwick Landing Dam and the 9 foot channel will be complete from Pickwick Landing Dam on up to Chattanooga, with minor improvements at Hales Bar.

Examination by the Court:

When all the dams proposed under the TVA Unified Plan are completed in the Tennessee River, there will be a channel that has sufficient depth for boats of 9 foot draft. It will be 9 feet or better. In fact the minimum depth will be around 11 feet. That will be produced by the dams that are in the Tennessee River alone.

Direct examination continued:

Prior to the construction of Gilbertsville Dam, over considerable periods of the year, the depth in the channel below Pickwick Landing Dam will be in excess of 7½ feet which would be the minimum depth and it would run up to 8½ or even 9 feet as the flow during the winter season increased. Navigable channels of a minimum depth of 7 feet or less have been considerably used by commercial navigation in this country.

I have on a great many occasions personally consulted with the Army Engineers and I have made many field inspections in company with the Army Engineers with respect [fol. 1386] to the navigation features of these projects which are completely in my province. The Corps of Engineers of the U. S. Army has prepared the designs for the locks that

have been put in the TVA dams which have been constructed or are under construction. In the dams either under construction or proposed below Florence, Alabama, we would have the large locks, 110 feet by 600 feet. Above Florence the locks we are constructing or propose to construct would be 60 feet by 360 feet. At the time we were considering the construction of Pickwick Landing we made quite a study of the size of the locks above and below Florence, and we also took it up with the Chief of Engineers of the Army and he wrote to us. I have a copy of the letter and the original laid on my desk for my information for a good many months. It came to me in my official capacity. I made considerable study of economical lock size on the Tennessee River and I concluded that the area around Florence, Alabama, was an important industrial area and had considerable potentialities, and that it would be reasonable to have the large locks to carry navigation up that far. There was also some consideration of digging a channel through from the Tennessee River to the Tombigbee River and the possibility of traffic through that route. That would come into the Pickwick pool. So that was another reason for having the large locks below Florence. Above Florence, there were four small locks existing and it seemed unreasonable to build a large lock at Gunter'sville Dam when there were three small locks below it and one small lock above it. Likewise above Chattanooga, if we then had four small locks below Chattanooga, it seemed unwise to put any large locks above that point. The determination that was made as to the size of the locks was checked with the United States Army Engineers. On occasions I have discussed with the District Engineer at Nashville or with other representatives of the Corps of Engineers the question of the design, [fol. 1387] size and capacity of the locks on these TVA projects.

I have made an estimate of the percentage of theoretical capacity, which existing Lock No. 1, Wilson Lock, and the locks above Wilson, excepting Hales Bar lock, will carry, and I have concluded that if you take 40 per cent of the theoretical annual capacity of these locks, it would represent the suitable, practicable capacity. In the studies which I helped to make in House Document 328, we assumed 50 per cent of the theoretical capacity would be practicable, but I have taken 40 per cent in these studies. Provisions have been made at each of these dams above Florence for

the installation of additional and larger locks, 110 by 600 feet, at a later date.

The photograph (offered and received in evidence as Defendants' Exhibit 99) shows the steamboat "Gordon C. Green" in the Pickwick Lock, and to my knowledge accurately represents the boat and the lock. The "Gordon C. Green" is an excursion boat from Cincinnati, Ohio.

The photograph (offered and received in evidence as Defendants' Exhibit 100) shows a tow of cement barges in Wheeler lock and accurately represents the layout of the lock.

The photograph (offered and received in evidence as Defendants' Exhibit 101) shows the lower approach to the Guntersville lock with the N. C. & St. L. car ferry entering the lock and actually portrays the physical layout of the approach to the lock. It does not show all the lock but the approach.

[fol. 1388] Cross-examination:

The lock is in operation with low temporary gates.

Direct examination continued:

The pile of dirt in the foreground is a spoil bank left there after the cofferdam was taken down. It is temporary and may be removed. Guntersville Dam is still under construction.

Cross-examination:

The car ferries at the time this picture was taken did not go through Guntersville lock without any operation of the gates as they had been doing for the past 25 years, as there was operation of the temporary gates. I think the picture was taken May 27, 1937.

"Mr. Fitts: I would like to make this statement to Mr. Jackson and to the Court, if what is bothering Mr. Jackson is whether or not the N.C. & St.L. ferry can get through the Guntersville Lock, as the Lock will be when completed, we are perfectly willing to state here, definitely, that it cannot get through without breaking tow."

Direct examination continued:

In May, 1933, in the section of the river between Florence and Riverton, Alabama, the controlling or minimum depth at low water was only 4 feet and there was a series of cuts that were dredged through reefs that were quite narrow, 160 feet in width. Between Riverton and the mouth of the river, the controlling depth at low water was $4\frac{1}{2}$ feet and the channel was in somewhat better condition than immediately above, but there was nevertheless a series of dredged cuts in that section also. At the time construction was started on Norris Dam, the plans were quite indefinite as to the development of the lower river. The Army Engineers had investigated the possibilities of a high dam at Aurora Landing and also the possibilities of a series of low dams in that section. There had always been a good deal of doubt about foundation conditions at Aurora Dam site, and there was nothing definite as to whether it could or [fol. 1389] would be built. In my opinion the stream flow regulation that will be provided by Norris and Hiwassee Dams will have a beneficial effect on navigation in the lower section of the river. The release of stored water from Norris and Hiwassee Dams during an ordinarily low water year will be sufficient to maintain the minimum stream flow throughout the entire river below Florence at about 18,000 cubic feet per second and will increase the previously existing minimum depth from $4\frac{1}{2}$ feet to a new minimum depth of about $7\frac{1}{2}$ feet, which would have an important effect toward increasing commerce in the lower part of the river.

Examination by the Court:

I stated a few minutes ago that when we completed the series of dams under the TVA Unified Plan on the main river, there would be at all times a channel depth of 9 feet.

"Judge Gore: Then why release the water at Norris when you have the 9-foot channel?"

Mr. Fitts: We are talking about it right now, that may be six or seven or eight years in the future.

Judge Gore: Oh, before it is completed?

Mr. Fitts: Yes, before Gilbertsville Dam is finished."

Direct examination continued:

In 1936 the releases from Norris Dam during the summer were sufficient to maintain the stream flow in the lower

section between Florence and the mouth of the river at a minimum of about 15,000 cubic feet per second, which increased the minimum depth in the lower section from $4\frac{1}{2}$ feet to a minimum depth of about $6\frac{1}{2}$ feet. In 1937 the Norris releases maintained the minimum stream flow below Florence at about 17,000 cubic feet per second, which increased the controlling depth from $4\frac{1}{2}$ feet to about 7 feet. When Hiwassee Dam is completed, it will add to that. [fol. 1390] Those releases are reregulated to a certain extent by operations at Wilson Dam. Prior to the creation of the TVA, when there was a continuous 24-hour flow in the river at Wilson Dam of 12,300 cubic feet per second, the Army Engineers did not allow any fluctuation of the stream flow but passed it right on through the dam. As the average flow increased to 15,000, they allowed the reduction to about 13,800 cubic feet per second, or an increase to a little over 18,000 throughout the 24-hour period. Since the construction of Norris Dam, the TVA has adhered substantially to that rule of the Army Engineers except on a few occasions where there were special reasons for making some adjustment. In my opinion, I believe this rule of operation sufficiently protects the interests of navigation below the Wilson Dam.

Assuming the 9-foot channel is provided throughout the length of the river by the construction of the seven high dams on the main stream as reported in the Unified Report to Congress, in my opinion Norris and Hiwassee Dams will then provide a material benefit to navigation on the Tennessee River. I have noted down a list of what I consider the advantages. The regulation that is provided by those tributary reservoirs will tend to stabilize the pool levels on the main stream. They will reduce flood discharges and flood velocities which certainly interfere with navigation at times. They will increase the navigable depths at the upper ends of each of the main stream pools. The tributary reservoirs will retain silt from the tributaries and thus reduce the silting of the navigable channel on the main stream, and in general will increase the flexibility of the operations of the main stream reservoirs for their multiple purposes and at the same time maintain the navigable channel.

[fol. 1391] The releases from Norris and Hiwassee Dams during low flow periods will have a beneficial effect upon navigation conditions upon the lower Ohio and the Missis-

issippi. There are periods when boats navigating on the Mississippi encounter inadequate depths in low water seasons. In my opinion the releases of storage water from the tributary dams would increase the depth of the navigable channel on the Mississippi River and would certainly be of benefit to navigation on the Mississippi since navigation is considerably handicapped during each low water season.

In my opinion it is desirable, in constructing a tributary storage dam such as Norris Dam, to provide that the navigation channel could be at some time continued. It certainly would be a poor policy to entirely foreclose navigation on an important tributary, and it would be the best way to obtain a navigable channel on the tributary to have that pool so used. The water that is below 955 at Norris Dam, which has been denominated "dead storage," could be used as such a navigation pool.

We made a considerable study of the possibilities of navigation through Norris Dam and the traffic potentialities on the Clinch River, and we decided that the greater part of the potential traffic on the Clinch would be a downstream movement of coal. It seemed to us entirely feasible to move this coal from the upper Norris pool down to the lower pool below the dam by putting it through a coal conveyor rather than by building a lock or barge lift. I am familiar with the plans which the Corps of Engineers had for a dam at the site of Norris.

The chart (offered and received in evidence as Defendants' Exhibit 102) is entitled "Coal Transfer and Transit Facilities, General Plan, Norris Project, Tennessee Valley Authority, Water Control Planning Department." It was prepared to show how the coal conveyor could be used in passing coal through from the upper pool shown on the right hand side of the drawing.

The chart (offered and received in evidence as Defendants' Exhibit 103) is entitled "Coal Transfer and Transit Facilities, Section and Elevation through Transit Point and Non-Overflow Section." It was prepared for the same purpose as I stated with reference to Defendants' Exhibit 102. [fol. 1393] On Defendants' Exhibit 102 the upper pool of Norris Dam is shown on the right hand side of the drawing. There is an item there shown as lake cargo barge containing coal. This barge would be unloaded by the system of conveyors at the wharf barge and the coal carried through a system of belt conveyors through the dam over to the

downstream side of the dam and into the item marked "10,000 ton transit coal bin," and from that by belt conveyors to the barges on the lower side of Norris Dam.

Examination by the Court:

As to what we want to do with the coal after we get it over there, it may be loaded into barges to continue down the Clinch River, whenever the Clinch River is developed to the point where it can be navigated by barges of this size. There is no project authorized to develop the river below the dam so as to make it navigable. There was a proposed or recommended project in House Document 328 covering that, showing the possibilities, but it has not been authorized. It is true that in the low water seasons there is practically no water below the dam, only about a foot or two of depth. This exhibit shows a layout which would be usable if Norris Dam became part of a through navigation system on the Clinch River. I would not say that this could be at once installed and used with the Clinch River in its present condition.

Direct examination continued:

There is not at present any plan to use this sort of a layout, but merely that this is a reasonable sort of layout to be used at Norris Dam if anyone determines to develop the Clinch River for through navigation.

[fol. 1394] **Examination by the Court:**

As to whether, if we develop the Clinch River below the dam for navigation we are going to destroy the reservoir entirely and will not have enough water above there to assist navigation, for power or anything, we would improve the river below Norris Dam by a system of locks and dams, in other words by a canalized project.

Direct examination continued:

We would have to build other dams on the Clinch River below Norris. Those dams were studied in House Document 328. There is at the present time a tunnel through Norris Dam near the uppermost portion of the dam on the line that is indicated on Defendants' Exhibit 102. That tunnel does not serve any other purpose.

The chart (offered and received in evidence as Defendantss' Exhibit 104) is entitled "Comparison of High Dam and Low Dam plans on Tennessee River." It shows the Tennessee River in profile, Knoxville being at the upper right hand side of the exhibit and Paducah being at the lower left hand side of the exhibit. On that profile I have superimposed the low dams as shown in House Document 328, which are the blue dams on the chart and the black ones on the photostat, and over the low dams I have superimposed the high dams, constructed, under construction or proposed by the TVA. It shows the manner in which the high dams of the TVA would eliminate the necessity for the low dam development—that is, how many low dams would be eliminated by each of the high dams.

In my opinion it would be possible, in times of high flows on the main stream of the Tennessee River, to draw down the main stream dams below the navigation levels that are [fol. 1395] shown on the exhibit and still maintain the project depth. For example, on the Gilbertsville Dam, I showed the minimum pool level at elevation 354. During the early part of the flood season, when it was desired to provide still more capacity in Gilbertsville Dam for flood control, it would be possible to draw that level down to say elevation 350 and depend upon the inflow to maintain the 9-foot navigable depth in the upper end of the pool. That is possible just from the simple hydraulic relationship that increased flow will increase depth in a given channel.

I have made a study of the low dam plan as outlined in House Document 328, and in my opinion the channel provided by the low dam construction would be decidedly inferior to that provided by the high dams. The high dam system as being carried out by the TVA would reduce the lockage time in making a trip from Paducah to Knoxville, would have much lower current velocities than in the low dam plan, would have more stable pools than the low dam pools, and there would not be the great fluctuations in stage. The cost of operation and maintenance of the navigation facilities would be less under the high dam system because of the fewer number of locks, and the high dams would provide additional navigable channels on the tributary streams, which would not be provided by the low dams. The high dam pools would provide much greater navigable depths throughout by far the greater part of the length of each pool than would the low dams, and the width of the channel

would be much greater in the high dam pools and the flood interruption to river commerce would be much less in the high dam pool.

The table (offered and received in evidence as Defendants' Exhibit 105) is entitled "Time Saved in Lockages with TVA High Dam Plan as Compared to a Low Dam Plan, assuming the same size of Locks in each Plan." The table in the upper half shows the time that will be saved in lockages with the TVA high dam plan as compared with the [fol. 1396] low dam plan in making a trip from Paducah, Kentucky, to Knoxville, Tennessee. In the first line of that table, Paducah to Florence, it is indicated that under the low dam plan the navigator would consume 3.62 hours and under the high dam plan 1.3 hours, and the saving in that section of the river due to the high dam plan would be 2.32 hours. Carrying these computations through, the totals show that the saving in time due to the high dam plan throughout the river would be 11.98 hours.

Examination by the Court:

The term "single lockage" means that the tow is of such size that it would go through the lock without breaking tow.

Direct examination continued:

I assumed that it would take 31 minutes to go through the low dam locks and 39 minutes through the high dam locks, except for Wilson lock where I made some further adjustments. That lockage time would be considerably increased if it took longer to go through those locks than that. I think I have assumed a very conservative figure for lockage time, because there are often delays at each lockage that do not have anything to do with operating the lock itself. But the more locks you have, the more delays you will have, so I think the lockage time under the low dam plan will probably be greater than this.

The chart (offered and received in evidence as Defendants' Exhibit 106) is entitled "Comparison of Velocities of High Dam and Low Dam Pools." It shows the ratio of the current velocities in the high dam as compared with the low dam pools. For example, on the 40 per cent of time line, as shown on the lower part of the chart, running up [fol. 1397] vertically on that 40 per cent of time line, the velocity which would be equalled or exceeded throughout

70 per cent of the length of the river with the low dam system, would be 3.25 times greater than the velocities equalled or exceeded throughout that same length of the river with the high dam system. To find that figure you follow the 40 per cent line vertically up to the curve marked "70," and then go horizontally to the left hand scale and it reads 3.25. The vertical scale shows the ratio of velocities in the low dam system to the high dam system. That is, if you go up to the line marked "3," that would be the line on which the low dam velocities are three times the high dam velocities. Likewise, if you go up to the horizontal line marked "4," that would be the horizontal line on which the low dam velocities are four times as great as those of the high dams. The horizontal scale shows the percent of time during which these velocities would be equalled or exceeded.

Cross-examination:

The absolute velocities are not shown on the chart.

Direct examination continued:

The percent of time is very important, because at extreme low water when there is almost no flow in the river, the low dam and high dam velocities would tend to be more or less the same, but as you get a little flow the low dam velocities become considerably greater than the high dam velocities, and it is best to relate the variation in stream flow to the percent of time over which these stream flows exist.

I think the lower velocities provided by the high dam plan would encourage a greater amount of traffic on the river and make it more profitable than would be possible [fol. 1398] under the low dam system. If a tow is progressing upstream, it has to proceed against the velocities which would cause a reduction in the towboat speed and cause an increase in the power output. Going downstream, there is not a complete compensation. You do not add the velocity of the current to the tow, because the navigator must proceed with considerable caution through the low dam system and he does not regain what he lost. Furthermore, there is apt to be considerably greater upstream traffic than downstream, which would mean that high velocities would have a serious effect. In the low dam system when the wickets are down, velocities are quite high. The veloci-

ties throughout the greater part of the low dam pool approach the velocities that would exist in the open river, and the velocity at the navigable pass is quite high and sometimes quite serious. With a bank-full stage it might be as high as five miles an hour and the tow would have difficulty in going through against such a velocity.

High floods at flood seasons increase the velocities in the stretch of the river below Wilson Dam. The high dam plan would cut down the velocities during the flood season, because the high dams provide a greater cross section of flow, and consequently, the large discharge through that section would have lesser velocity.

Floods or high flow conditions upon the main stream of the Tennessee River under the low dam plan as outlined in House Document 328 would have a detrimental effect upon navigation and navigation terminals. The high dam plan would provide a more stable pool level and would make the cost of terminal construction and operation cheaper than with the low dam system.

The greater channel depth under the TVA high dam plan allows a towboat to make a greater speed with the [fol. 1399] same output of power or to maintain the same speed as in shallower depths with a less output of power. The low dam plan of House Document 328 would have provided just barely a 9-foot depth. The depth provided under the TVA plan is 9 feet with an overdepth of 2 feet, which are the controlling depths in the upper ends of the pools. Throughout by far the greater length of the high dam pools, there will be substantially greater depth than in the low dam system.

The graph (offered and received in evidence as Defendants' Exhibit 107) is entitled "Depth Relation, Tow of Six Barges, 7 Ft. Draft." It shows data which was obtained from House Document 857 of the 63d Congress, Second Session, and House Document 108, 67th Congress, First Session. It shows the speed that could be maintained with various given horse power in various depths of water. For example, if you take a towboat of 400 H. P., on the vertical line marked 400 at the bottom of the graph, and follow that line upward to intersect the depth of 24 feet, which is a heavy horizontal line a little below the 25-foot mark, it is there shown that the speed as indicated by interpolation between the mark of 5 miles per hour and six miles per

hour would be about 5.3 miles per hour. Dropping back on the same vertical line to the 15-foot depth line, it is shown that the speed would be 4.7 miles per hour; and at the 9-foot depth line, the speed would be about 4.3 miles per hour. The exhibit shows that there is a considerable variation in the speeds that are obtainable with a given amount of power, as the depth increases from 9 feet up to 25 feet. The advantage of the greater depth would be increased if you have the 9-foot draft. This chart is based on the 7-foot draft because that is what the original data was based upon. This advantage would be of still greater significance if the speeds and the power of the vessel were increased.

[fol. 1400] The table (offered and received in evidence as Defendants' Exhibit 108) shows the percentage of the linear distance of each pool under the TVA high dam plan, which will be less than 20 feet in depth. At Gilbertsville pool, only 2 per cent of the length will be less than 20 feet in depth, and in the Pickwick Landing pool, only 4 per cent. In the lock and dam No. 1, which is the Florence canal, which is an existing improvement, 100 per cent of that will be less than 20 feet in depth. In the existing Wilson Dam pool, about 7 per cent of its length is less than 20 feet, and in Wheeler Dam pool, about 6 per cent of its length will be less than 20 feet; in Guntersville pool, 18 per cent; in Hales Bar pool, 23 per cent; in Chickamauga pool, 6 per cent; in Watts Bar pool, 3 per cent; and in Coulter Shoals pool, 5 per cent. The table does not show the minimum width of the pools. The absolute minimum width reached below each lock would be 300 feet, because there is a dredged cut below each lock, and that is only a matter of a few hundred feet up to a thousand feet as a rule. The 20-foot pool does not reach right below the lock, as that is where the 2 per cent in the Gilbertsville pool would exist, right below the Pickwick Lock.

"Mr. Fitts: I offer that in evidence as Defendants' Exhibit 108.

Mr. R. T. Jackson: I object on the ground it does not show the width. The 20 feet depth does not mean anything.

Judge Allen: Objection overruled. It will be received in evidence.

Mr. R. T. Jackson: May we have our exception?

Judge Allen: You may have your exception."

I have prepared a table which shows the percentage of channel distance under the low dam plan as outlined in House Document 328 which is less than 20 feet in depth. In the reach of the river which would be improved by the [fol. 1401] Gilbertsville Dam, if that reach were improved by low dams, 39 per cent of that distance would be of less than 20 feet in depth. In the Pickwick reach under the low dams, 54 per cent of the distance would be less than 20 feet in depth. In the existing Florence Canal, it would be 100 per cent as before, and in the Wilson pool, it would be 7 per cent as before. In the Wheeler reach, if that were improved by low dams, 67 per cent of the channel distance would be less than 20 feet; in the Gunter'sville reach, 79 per cent; in the Hales Bar reach, 25 per cent; in the Chickamauga reach, 62 per cent; in the Watts Bar reach, 49 per cent; and in Coulter Shoals, 61 per cent.

The chart (offered and received in evidence as Defendants' Exhibit 109) is entitled "Improvement on Tributaries Provided by High Dam Plan". It shows the extent of the slack water development that would be provided on the tributary streams by the back water from the high dams on the main stream, in the case of the Clinch River by Norris Dam. For example, the Gilbertsville Dam on the lower Tennessee River would extend the 9-foot channel up Duck River about 12 miles. The distance which the 9-foot channel will extend on the tributaries is shown on the map by the heavy line and the shading off into lighter colors shows where the 9-foot channel ceases. Pickwick Dam would extend the 9-foot channel up Bear Creek about 23 miles. Wheeler Dam would extend the 9-foot channel up the Elk River to about the state line. Chickamauga Dam will extend the 9-foot channel up the Hiwassee River about 20 miles. The Watts Bar Dam will extend the 9-foot channel on the lower Clinch River and up the Emory River to the vicinity of Harriman. The Norris Dam would extend the 9-foot channel on the Clinch River, with its reservoir in its draw-down condition, a distance of about 56 miles. The [fol. 1402] Coulter Shoals Dam would extend the 9-foot channel up the Little River some six or eight miles to Rockford, Tennessee. The low dam plan outlined in House Document 328 would produce practically none of that improvement on the tributaries. In order to get that improvement on the tributaries with low dams on the main stream, you would have to build low dams on the tributaries also.

For example, the comparable improvement on Duck River would take two low dams, three on Bear Creek, about three on Elk River, at least one on Hiwassee and one on the Emory. On the Clinch River it would depend on the layout there and how high they were. Several would be needed on the Clinch River and one on the Little River. In my opinion that improvement is of practical significance. The Duck River is one of the principal tributaries and it comes from the phosphate field area. If it was advisable eventually to develop that stream for navigation there would be a part of the project already accomplished. If the Tennessee-Tombigbee Canal were developed, the slack water provided by Pickwick on Bear Creek would be of considerable value.

Examination by the Court:

Mt. Pleasant is on the Duck River and is a considerable distance from its mouth on the Tennessee. I am not sure how far it is. Mt. Pleasant is in the center of the phosphate fields. Pickwick will only back the water up that river about 12 miles and that 12 miles will not reach the phosphate fields.

[fol. 1403] Direct examination continued:

It is the Gilbertsville Dam, not the Pickwick. You will get 12 miles of that distance whatever project is required to provide a 9-foot channel. The 9-foot channel provided by Wheeler Dam backs the Elk River up to an existing phosphate field and the slack water from Chickamauga extends up the Hiwassee River to Charleston and Calhoun, Tennessee. The slack water on the lower Clinch and Emory Rivers, as provided by Watts Bar Dam, reaches to Harriman, which is an important town, and the slack water provided on the Clinch River by Norris Dam will eventually be of some navigation value.

There is a relation between adequate terminal facilities and the development of the movement of commerce on the river. It is necessary to have adequate terminal facilities in order that commerce may be taken care of. The ratio of terminal cost to line-haul cost in water transportation is substantial. The high dam pools would provide quite a stable pool level which would make it much cheaper to construct and operate the navigation terminals and would aid in the development of an adequate system of public terminals throughout the course of the river.

"Q. In actual experience has the fluctuations of water levels upon the internal waterway systems had any effect upon the feasibility of the construction and operation of river terminals?

Mr. R. T. Jackson: I object to that as too indefinite.

Mr. Fitts: The Mississippi River system, I will reframe my question.

Mr. R. T. Jackson: I object to that, because the evidence shows that system takes in 40 per cent of the United States and 9,000 miles of waterway. I think that is too much for us to go into.

Mr. Fitts: May it please the Court, it is utterly impossible to consider navigation upon the Tennessee River as an isolated creek. The Tennessee River is connected with other interconnected waterways.

[fol. 1404] Judge Allen: Objection overruled. The river does not operate in vacuo.

Mr. R. T. Jackson: If your Honor please, terminals on the Tennessee River will not be operated on the Mississippi and the Missouri. May we have our exception?

Judge Allen: You may have your exception. The question will be answered.

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Mr. R. T. Jackson: I would like also to object on the ground of the competency of the witness.

Judge Allen: Overruled.

Mr. R. T. Jackson: Exception noted.

A. Yes, it has had effect on the construction and operation of terminals, upon large operations of the inland waterways. The fluctuation stage is very great, and it has been necessary to build terminals to great height and to handle freight through very great vertical distances, which increases the expense."

I have made a study of the extent of fluctuations in pool levels which would exist in the various pools under the low dam plan as provided in House Document 328 and under the high dam plan as carried out by the TVA. The main terminals to be projected or considered or started at the present time are at Wilson Dam, at Decatur, Alabama, and at Guntersville Dam.

The chart (offered and received in evidence as Defendants' Exhibit 110) is entitled "Comparison of Pool Fluctuations with High Dams and Low Dams."

"Mr. Fitts: We offer in evidence the exhibit which is the chart on the standard, which has been identified by the witness as Defendants' Exhibit 110.

Mr. R. T. Jackson: We object to it as misleading upon the ground it only relates to three selected points on the river and leads to the impression it relates to the fluctuation of the whole river.

Judge Allen: It is a comparison of pool fluctuations with high dams and low dams at three certain points.

[fol. 1405] Mr. Fitts: It shows three points. We can put in the language on there the Court thinks desirable. I thought showing on its face it was at three points, that it would not purport to show anything but the three points.

Judge Allen: Objection overruled. The exhibit will be received.

Mr. R. T. Jackson: May we have our exception to the ruling on exhibit 110?

Judge Allen: You may."

Defendants' Exhibit 110 shows a comparison of pool fluctuations between the high dam and low dam conditions. The higher fluctuations shown in the dark color are the variations between the minimum water surface elevation with the low dam development and the flood levels caused by the maximum flood of record; and the lower elevations shown in white are the variations between the draw-down levels and those which would be reached by the maximum flood of record passing through the high dam system. The figures are in feet and, for example, take Decatur, the fluctuation of pool level with the high dam system would be about 14 feet and with the low dam system about 22 feet. In my opinion I think the lower fluctuations provided by the high dam plan would facilitate the construction and operation of navigation terminals and would encourage the development of an adequate system of terminals.

I have made an estimate of the amount required to maintain and operate the locks and dams and carry on the necessary dredging in the low dam plan as outlined in House Document 328. Under the low dam plan I estimate that the cost of operation and maintenance would be \$1,570,000 an-

annually and \$330,000 annually for dredging, giving a total for the low dam plan of \$1,900,000. I have made an estimate of the annual cost of operation and maintenance of the TVA high dam plan. The estimate for the annual operation and maintenance of the locks in the high dam system would [fol. 1406] be \$370,000 and dredging per annum \$220,000, giving a total for operation and dredging under the high dam plan of \$590,000. The low dam system annual charges for operation, maintenance and dredging would exceed the high dam plan by \$1,310,000. As to how I explain the difference between my figures and those given by Major Putnam, I added the figures I could find from Major Putnam's testimony and the sub-total in his testimony was \$1,092,730 and that compares with my figure of \$1,570,000. His dredging figure for the low dam scheme was \$489,000 and mine was \$330,000. I believe Major Putnam gave a total for operation, maintenance and dredging under the low dam plan of \$1,581,730 and my comparable figure is \$1,900,000. In the high dam scheme Major Putnam's total figure for operation, maintenance and dredging was \$994,730 and my comparable figure was \$590,000. I think the cost of the operation of the low dams should be increased over what Major Putnam had. I estimate for a low lift lock and dam about \$40,000 per dam.

I should think the effect of wind action would be more serious in the low dam channels than in the high dam channels. With a long tow it is quite often the case that the wind forces such a tow out of a narrow channel and it is hard to manage. I think the waves would be higher on high dam pools. On most of the developments the wind action in forcing a tow over to the side of the channel and causing it to ground is one of the most common obstacles or hazards to navigation. In my opinion the existence of a wide channel would be of advantage to the navigator in preventing groundings on reefs and bars because of wind conditions. The navigator likes to have plenty of room in which to maneuver and operate, and I think he would be subject to much less hazards if he had this greater channel width provided by the high dam scheme. I would prefer the wide channels of the high dam plan. I think it is conducive to better navigation.

[fol. 1407] At Pickwick Dam, which is the only dam under construction below Wilson Dam, a provision has been made

for the installation of an additional small lock later, if needed.

The letter (offered and received in evidence as Defendants' Exhibit 111) is a carbon copy of the letter dated September 1, 1934, addressed to the District Engineer, United States Engineer's office, Nashville, Tennessee, signed by James S. Bowman, hydraulic engineer, and later referred to the Chief of Engineers. I conferred with Mr. Bowman on the writing of this letter.

The letter (offered and received in evidence as Defendants' Exhibit 112) is the letter TVA received from the Chief of Engineers in regard to the sizes of the locks that should be constructed on the Tennessee River. It was referred to me in the course of my official duties, and at that time and many times thereafter, I had occasion to examine it. It was the guide in my studies in this matter of lock sizes. This letter (Defendants' Exhibit 112) states the following requirements adopted by the War Department for different sections of the river as the minimum provisions necessary to meet the needs of navigation: Upper Tennessee River, locks 60 feet by 360 feet to be constructed at the time the dams are constructed, with space enough for locks 110 feet by 600 feet; Middle Tennessee River, locks 60 feet by 360 feet to be constructed at the time the dams are constructed, with space enough for locks 110 feet by 600 feet; Lower Tennessee River, locks 110 feet by 600 feet to be constructed at the time the dams are constructed, with space left for locks 60 feet by 360 feet. These requirements have been met.

In the high dam plan, as being carried out by the TVA, the channel width immediately below the locks would be around 300 feet and that would obtain for just a short distance, maybe a matter of a half mile or a mile. Then the channel would widen out to the natural width of the river [fol. 1408] for a distance of several miles, and then it would widen again to a width of from three quarters of a mile to a mile for the greater part of the pool length. As you approach the dam, it would widen again to a width of a mile to a mile and a half and in a few places to perhaps two miles. In the low dam pools, starting at the upper end of the pool, there would be a width in the largest channel of from 200 to 300 feet, and continuing downstream it would widen out somewhat, but not nearly as rapidly as in the high dam system. There would be reefs and bars on either

side of the channel for a very substantial distance throughout the low dam pool, but as you get into the middle and lower sections of the low dam pool, the channel would widen to the width that we now have in the river, which would be from 1200 feet up to half a mile.

The maximum width of the Gilbertsville reservoir is around five miles and the average width is around a mile. The Pickwick pool is comparatively narrow, and the maximum width is around a mile and a half, and the average width somewhat less than a mile. The Wheeler pool in its maximum width is about $2\frac{1}{2}$ to 3 miles and its average width about a mile. The Guntersville pool is quite wide just upstream from the dam and is about two to two and one-half miles in width, but it is considerably narrower in its average width than the Wheeler pool, probably averaging $\frac{3}{4}$ of a mile in width. The Chickamauga pool is a comparatively narrow one, the maximum width being probably a mile or a mile and a half and the average width considerably less than a mile.

The map (offered and received in evidence as Defendants' Exhibit 113) is entitled "Wheeler Reservoir and Surrounding Region", was prepared by me or under my supervision and direction and the facts shown on it are accurate and correct. The heavy black line is the natural river channel as it existed before Wheeler Dam was constructed and the shaded area represents the Wheeler pool as it now exists.

"Mr. Fitts: We offer in evidence as Defendants' Exhibit No. 113 the exhibit just identified by the witness.

Judge Allen: Any objection?

Mr. R. T. Jackson: Yes, we object to it because it does not show the elevations. It doesn't mean anything without the elevations.

Mr. Fitts: It is not offered for that purpose.

Mr. R. T. Jackson: It may be offered just for confusion, but it doesn't mean anything without the elevations."

The Wheeler pool is shown at around elevation 555 and any variation of a foot or two or three would not be apparent on the map, as you could not tell the difference in the width of the pool with a magnifying glass on that small scale. The scale is not too small to show anything, but the general outline of the pool is shown at approximately elevation 555.

"Judge Allen: The Court rules that the exhibit may be admitted, but we feel that it would be helpful if the legend showed the distinction between the heavy shaded line and the lighter.

Mr. Fitts: I think the Court is clearly correct and we will see that it is done.

Mr. R. T. Jackson: May we have our exception with reference to the failure to record the elevation on the map?

Judge Allen: Yes."

Defendants' Exhibit 113 shows the comparison of the pool widths with the high dam pool and approximately as the channel would be with the low dams. Starting at the left hand side of the chart at Wheeler Dam, the present Wheeler pool is about the same width as the natural river, because that was the head end of Muscle Shoals, and the river widened out there to about the same width as it now is even [fol. 1410] under natural conditions. Proceeding upstream from that point, the natural river narrowed down considerably as compared with the existing Wheeler pool and it widened out again to approximately the width of Wheeler pool at a point opposite the mouth of the Elk River, which was the first tributary coming in from the north. The wide place in the natural river was caused by Elk River Shoals. The natural river then narrowed down to be considerably less than the width of the Wheeler pool throughout the remainder of the distance to a point two or three miles above Decatur, Alabama, and from there on the present Wheeler pool and the natural river channel become approximately the same width all the way to Gunter'sville Dam at the extreme right hand side.

In my opinion the high dam channel will be of such substantial width that there will not be the hazard in nearly as great a degree of blowing navigators on to the reefs on either side of the navigable channel. The Wheeler Dam pool has been filled something over a year. During that time word of any disaster to navigation has not come to my personal knowledge. Nothing that I would call a disaster to navigation. During the construction of the Wheeler and Gunter'sville Dams, the TVA had occasion to use Wheeler and Wilson lakes frequently for the movement of construction material. What you might call old-fashioned Ohio River equipment, in other words, old stern-wheel steamboats with very small freeboard and steel barges of comparatively

small freeboard when loaded were used in that service. There had not been any substantial interference in their movement in these pools by wave action. I know of an incident at Wheeler Lake in April, 1937. In the latter part of April, 1937, there was a heavy windstorm in Northern Alabama which created waves on the Wheeler pool, and these waves drove debris into the machinery recesses where the lock operating machinery is housed, and the waves also went [fol. 1411] the gate operating motors. The debris had to be cleaned out of the recesses and the operating motors taken out and dried. The Army Engineers put temporary wooden bulkheads into the machinery recesses which will protect the machinery from waves, and they have plans under way for permanent bulkheads which will protect the machinery. The maximum fetch on Wheeler reservoirs is about eight to ten miles.

"Q. Mr. Barker, in your opinion will it be necessary to design new types of equipment to operate on the Tennessee after the improvement is completed?

Mr. R. T. Jackson: Just a moment. I object to the competency of the witness to answer this question.

Judge Allen: Objection overruled.

Mr. R. T. Jackson: May I have an exception, please?

Judge Allen: You may.

A. I do not think it will be necessary to obtain different types of equipment. As new equipment is designed and purchased by the boat operators, I believe they are tending toward more substantial equipment, and will continue to do so in the future. But, I have no doubt but what the older equipment can successfully operate on these pools."

Wheeler pool is the only pool that has been put into operation since the TVA was established. The TVA in cooperation with the Army Engineers have carried out an extensive program of stump removal in Wheeler pool on either one or both banks as considered necessary by the Army Engineers. This stumping was done under the supervision of the Army Engineers and with their full approval after it was done. The Army Engineers in connection with the lighthouse authorities have established aids to navigation, such as channel buoys and channel lights. Certain indentations in the shores of the reservoirs have been en-

tirely cleared of stumps for use as safety harbors in case those harbors are needed by navigation. I personally participated with the Army Engineers throughout that work. [fol. 1412] The document (offered and received in evidence as Defendants' Exhibit 114) is a notice to navigation interests of the type periodically gotten out by the Army Engineers in the Nashville, Tennessee, office. This particular notice marked No. 32 pertains to the Wheeler pool and shows the location of the channel and the areas where stumping has been accomplished and the location of such navigation aids as have been installed up to this date. I had been consulted right along as to where the stumping should be done and where the navigation aids should be placed, and the course of the official sailing line. A copy of this notice was sent to me.

In my opinion, adequate protection will be provided to the navigator in case of storms on the Wheeler reservoir.

Examination by the Court:

The protection provided in the construction is the removing of the stumps, the placing of buoys, the marking of channels, the placing of safety harbors, and the clearing out of the coves.

Direct examination continued:

The table (offered and received in evidence as Defendants' Exhibit 115) shows the relative efficiency of the high dam system and the low dam system measured by savings in time of navigation.

Examination by the Court:

This exhibit takes into consideration only the time consumed in lockages and in running up and down the stream with the speeds affected by the velocity of the currents. Miscellaneous delays in the fourth line of the table is any unusual delay in approaching the lock or any minor accident, such as temporarily running aground.

[fol. 1413] Direct examination continued:

I do not believe it fully represents the superiority of the high dam system over the low dam system, because I have taken into consideration here only a part of the factors that

go to make up the differences between the low and high dam plan.

I am familiar with the present practices and standards of the Corps of Engineers with respect to navigable channels upon the rivers of the United States as to the matter of depth, width and physical structures, and I have made a complete study of the low dam system set up in House Document 328.

"Q. I will ask you whether or not in your opinion that system as set up in House Document 328 would meet the present standards of the Corps of Engineers?

A. No, I do not believe it would.

Mr. R. T. Jackson: Just a moment.

Mr. Fitts: Did you want to object to the question that was asked? You had plenty of time.

Judge Allen: The answer was 'No.' He did not believe it would.

Mr. R. T. Jackson: I understand. I move to strike out the answer because I wanted to object to the competency of the witness to answer the question. And I would like to ask a few qualifying questions, if there is any doubt in the Court's mind.

Mr. Fitts: If there is any doubt about it I would like to have the qualifications read.

Judge Allen: Objection overruled.

Mr. R. T. Jackson: May I ask the qualifying questions?

Judge Allen: Yes."

[fol. 1414] Cross-examination:

I am not now a member of the Corps of Engineers. I was never a member of the Corps of Engineers of the United States Army. I was employed by them for about 10 or 11 years. I was a civilian employee working under the jurisdiction and direction of responsible officers of the Corps of Engineers of the United States Army with considerable latitude as to my judgment. Every decision and every recommendation that was made was made by and on the responsibility of the officer of the Corps of Engineers of the United States Army under whose direction I was working. I have not even worked as a civilian employee for the Corps of Engineers since 1933.

"Mr. R. T. Jackson: I don't think there is the slightest qualification to testify as to what the practice of the Corps of Engineers is, and I renew my objection and move to strike out his answer.

Judge Allen: The Court thinks that a man who has worked for eleven years under the Army Engineers, and who states he is familiar with their requirements, may answer the question. The objection is overruled.

Mr. R. T. Jackson: May we have our exception, if the Court please."

Direct examination continued:

The channel as provided by the low dam scheme in House Document 328 would have been just barely nine feet in depth. In fact, if you carefully plot up some of those dams, you will find it does not provide even a scant nine feet in some cases. The width of channel would not be fully adequate in the upper ends of the pools unless they did considerably more dredging than was therein provided. The low movable dams are considered out of date as navigation structures. The Army Engineers are not building any [fol. 1415] more dams of that type, and where they are called upon to build new dams in systems which now have the low movable dams, they are installing a much higher dam of entirely different type. I have made an independent study or estimate of what it would cost to obtain a channel upon the Tennessee River that would meet the present standards of using low dams instead of high dams.

"Q. What is that estimate?

Mr. R. T. Jackson: We object to the competency of the witness.

Judge Allen: The objection is overruled and you may have your exception.

Mr. R. T. Jackson: Exception noted.

A. I have laid out a system of dams with somewhat higher lifts than those shown in the House Document and have arrived at a total initial or construction cost of this system for the development of the river from Paducah to Knoxville of \$144,072,700."

The locks I used were the large size locks, 110 by 600, below Florence, Alabama; and the small locks, 60 by 360, above Florence, Alabama.

"Q. Mr. Barker, in your judgment, is that the lowest figure at which you could obtain a navigable channel throughout the length of the Tennessee River, meeting present standards and present requirements?

Mr. R. T. Jackson: Just a moment; I object to the question. There is no definition of what the witness thinks, or if he knows, what the present standards are.

Mr. Fitts: He has already defined them.

Mr. R. T. Jackson: I don't think so. He said he knew what they were, and something did not meet them, and that is all.

Judge Allen: The Court would like to have the present standards amplified.

By Mr. Fitts:

Q. Mr. Barker, will you state what you understand to be the present standards with respect to navigable channels on rivers such as the Tennessee.

Mr. R. T. Jackson: Subject to the objection that the witness is wholly without qualification to state what the standards [fol. 1416] are.

Judge Allen: Objection overruled.

Mr. R. T. Jackson: Exception, please.

A. Well, I thought that the first requirement would be to get away from the movable wicket dams and to install a dam that would be more rugged and less hazardous in operation. I therefore used fixed dams instead of the movable dams."

Examination by the Court:

As to what the standard is, as I understand it, it is a fact that the Army Engineers are not using the movable wicket dams. They are using what they call a roller gate dam, which is a fixed dam but with a spillway gate in which it will allow the discharge of the river but not allow boats through the gates. They are replacing the wicket dams with these fixed dams with roller gates or Taintor gates on the spillway.

Direct examination continued:

In this layout that I have described, I have provided overdepths of 2 feet, that is the nine foot depth plus a depth

of an additional two feet. There need not be as many lock lifts throughout the river as shown in House Document 328. To avoid having such a large number of locks, it is entirely feasible to have dams of somewhat greater lifts and, consequently, a fewer number. The greater depth of the pool provided, and the greater cross-section of flow provided through the pools, and the fact that the dams are fixed and not movable, would also reduce the velocities in these pools as I have laid out the projects.

“Mr. Fitts: The question was whether or not, in his judgment, the estimate which he had given was the lowest cost at which a navigable channel over the entire length of the Tennessee could be provided by the use of low dams.

[fol. 1417] Mr. R. T. Jackson: I object to the competency of the witness.

Judge Allen: The objection is overruled and you may have your exception.

Judge Gore: You mean to have a channel nine feet or more?

Mr. Fitts: Nine feet or more over the entire length of the Tennessee by the use of low dams.

The Witness: I think this is the lowest cost that could be obtained on a suitable project.”

The navigation channel on the Tennessee River will be connected with the Mississippi and Ohio systems following the completion of all the dams now under construction, constructed or recommended for construction. A nine foot channel has been adopted in the approval of the upper Mississippi and Ohio Rivers. The type of improvement which has been adopted on those streams is a canalization by locks and dams.

The map (offered and received in evidence as Defendants' Exhibit 116) is entitled “Tennessee River and Inter-connecting Waterways.”

Cross-examination:

The word “projected” means a project for waterway improvement authorized by Congress.

Direct examination continued:

All of the projects with broken lines, which are noted as projected, are under construction. The upper Mississippi

to Minneapolis and St. Paul is under construction. The Missouri up to Sioux City is under construction and the Tennessee is under construction.

“(By Mr. Fitts:) Mr. Barker, can you tell us how many miles of nine foot waterway there are in that system?”

[fol. 1418] Mr. R. T. Jackson: I object to that as irrelevant and immaterial.

Judge Allen: The objection is overruled.

Mr. R. T. Jackson: Exception, please.

A. If I may do so, I would like to supply that answer from notes which I don't have here.”

The barges which have been used on the Tennessee River up to the present time are mostly stern-wheel towboats, either steam or Diesel powered, and barges of either wood or steel construction, drawing four or five feet of draft and carrying from 300 to 500 tons of cargo. After the nine foot waterway is completed, those boats could continue to be used, but in addition, the largest of the towboats and barges used on the Mississippi and Ohio Rivers could also operate successfully on the Tennessee River, that is, propeller type towboats, either single or twin screw, of 1,000 to 2,000 horsepower, and barges drawing nine feet and carrying from 1,000 to 2,000 tons or perhaps even more. In my opinion the creation of this waterway will cause a very substantial waterway traffic to develop on the Tennessee River and between the Tennessee Valley and other regions of the United States connected by water, rail and highway.

“By Mr. Fitts:

Q. Mr. Barker, if you were instructed to provide a minimum nine foot navigable channel upon the main stream of the Tennessee River, and to aid in the control of destructive flood waters in the Tennessee and Mississippi River Valleys by means of dams constructed upon the Tennessee River and its tributaries, what dams would you build.

Mr. R. T. Jackson: Just a moment. I object to the qualifications of the witness. There has been no competency shown to pass upon the question of flood control.

Judge Allen: The objection is overruled and you may have your exception.

Mr. R. T. Jackson: Exception noted, please.

A. I would build the dams upon the main stream as constructed or proposed by the Authority, namely, the [fol. 1419] Gilbertsville and Pickwick Dams below Florence, Alabama, and from the upper end of the existing Wilson Pool, the Wheeler and Guntersville Dams, and then above Chattanooga, the Chickamauga, Watts Bar, and Coulter Shoals Dams, and also the Norris and Hiwassee Dams on the tributaries.

By Mr. Fitts:

Q. Would any other types of dams accomplish all of those purposes?

Mr. R. T. Jackson: The same objection, please.

Judge Allen: Objection overruled.

Mr. R. T. Jackson: Exception please.

A. No, they would not.

Mr. Fitts: This, then, was not accepted. All the others were accepted subject to correction but this was withdrawn and marked Defendants' Exhibit 96 for identification. This was the graph of tons of freight, which was apparently out of line. It has been corrected, shoved over, to show the picture as we understand it.

Judge Gore: You move it to the left six months?

Mr. Fitts: That is correct. It ends now with 1935.

Mr. R. T. Jackson: So the Court will see it, I have another objection to this, and that is the use of a very wide paint brush to mark the graph, the brush being so wide that it blankets a year at a time as the artist swings it up and down. For instance, here a difference of 600,000 or 800,000 tons, depending on whether you take one side of the artist's line, or another. Over here at the time of the second last depression there was a difference of 400,000 tons in 1929. I don't know whether I make clear to the Court what I have in mind, but right here one can see that with the use of this wide line there would be a difference of many thousand tons.

Judge Allen: The objection is overruled. In view of the testimony of the witness we feel that the chart is admis-

sible, and you may have your exception. Exhibit 96 is received. I might say that the same objection could be made to any exhibit, I think, as it is a matter of degree.

Mr. R. T. Jackson: Well, as I understand it, there is no necessity for having it anywhere nearly as wide as that.

Judge Martin: Brother Jackson, after all is it material to the final issues in this case to show exactly the amount on a given date there? It is merely a graph to show in general the trend.

Mr. R. T. Jackson: I do not think the whole graph is material, but when my adversary offers it, and the Court accepts it, I think I have to act on the ground my judgment is not good on that point.

[fol. 1420] Judge Allen: We accept it as a graph, showing the trend. I think that is all that was testified to about it."

Cross-examination:

I am not at the present time a subordinate of Mr. Bowman, who testified in this case. I was a subordinate of his under an organization that we once had. I was in the Division of which Mr. Bowman was head for the first three years that I was with the TVA. That was the Project Planning Division. I am not now in the Project Planning Division. I would not say I act independently of it, because we correlate our work. We are now in the General Planning Division, which correlates its work very closely with the Project Planning Division. The reorganization was in July, 1937, so I left the Project Planning Division on that date.

Shortly after I graduated from Minnesota, I was a civilian employee from 1924 to 1928 in the office of the District Engineer at Chattanooga. At that time there was a considerable number of additional civilian employees in that office by reason of the preparation of one of the 308 reports on the Mississippi River and its tributaries involving an unusual amount of work. That was in connection with the preparation of House Document 328. It is not right that those were studies of the water resources of all characters that were being made on most of the navigable rivers of the United States by the officers of the Corps of Engineers pursuant to a resolution of Congress. House Document 328 was created under various other authoriza-

tions. It finally was accepted as the 308 report but a great deal more work was put on it than on most of the 308 reports. It is a fact that a part of my time, while I was employed at Chattanooga, was spent in working on hydraulic studies and was devoted to a study of river flow, water [fol. 1421] stages and data of that character which the District Engineer desired worked up in connection with his preparation of his report; but I would not say a large part of my time, because I studied navigation, flood control, power and all of the related problems. As to whether I so testified in the Ashwander case, I do not remember what I testified. I am stating it correctly now I think.

From 1928 to 1932 I was a civilian employee of the United States District Engineer's office at Kansas City, Missouri. The work there was under the responsible charge of an officer of the Corps of Engineers of the United States Army who was United States District Engineer. During that period it is a fact that I was very largely engaged in working up data desired by the District Engineer for use in the preparation of the so-called 308 report. From September 1932 to March 1933, I was in charge of the Engineer's office at Sioux City, Iowa. It is a fact that that office was under the jurisdiction of the U. S. District Engineer at Kansas City, Missouri, but I was in personal charge of the Sioux City office and the only one in charge. What I was doing there was to carry out certain local work under the jurisdiction and supervision of the United States District Engineer at Kansas City, but I had personal and direct charge of the work between Sioux City and Omaha, involving about a million dollars worth of navigation improvement. That was under the U. S. District Engineer. He was not there but about once or twice all the time I was there. After that I was employed as civilian engineer in the office of the Corps of Engineers at Wilson Dam, which was then being operated for the generation of power and navigation. From there I went directly to the TVA. I never operated or managed the operation of a commercial barge line. As to whether I ever built, designed or operated [fol. 1422] a commercial water terminal, I have made preliminary designs for them for the TVA. I have never constructed or operated any commercial inland waterway terminal other than for the TVA. The TVA has constructed the inland waterway terminal at Decatur, which

will eventually be used, I believe, for public commercial purposes. The TVA is now using it for its own purposes. It is a building right on the water's edge with all of the structural features necessary for a navigation terminal.

Defendants' Exhibit 94 entitled "Maximum and minimum rates of stream flow, Tennessee River, Knoxville, Chattanooga, Florence and Johnsonville" shows the instantaneous maximum and minimum peak flows. The maximum flow at Florence of 470,000 second feet occurred in 1897. The stage of 32.5 feet was taken from Bulletin 40, "Surface Waters of Tennessee" and the flow that corresponds to that stage was computed by the TVA from its flood rating curves, from flood rating curves that had been prepared by TVA. There are flood rating curves for Florence prepared by the U. S. Geological Survey. As to why we did not use those, we found on the higher discharges there are some variations in the flow. We did not think they were exactly right on the highest discharges. We found that we got a slightly lower figure with the U. S. Geological Survey's curves, but we did not think they were right.

I testified in the Ashwander case and was asked the following question and made the following answer:

"Q. Will you describe the variations in the stream flow and the causes of those variations?

A. The stream flow varies a great deal seasonally from the low water to the high water season. It is due principally to variation in rainfall. The rainfall of the basin as a whole averages about 51 inches, but in east Tennessee and North Carolina, in the mountainous sections, it is extremely heavy. It runs up as high as 80 inches. This variation in stream flow in the summer months runs as low as about 8,000 to 10,000 second feet at Florence, Alabama. In the winter months at Florence, Alabama, it commonly runs between 100,000 and 200,000 second feet, and maybe as high as 400,000. The greatest flood record at Florence, Alabama, is 400,000 second feet."

However, I would like to explain those are general figures I testified to there and our subsequent studies show that the maximum peaks I have here on the exhibit are correct.

As to whether the maximum of record is a general figure, that I think was a 24 hour figure and besides we do not think it exactly accurate.

"Q. How long did your instantaneous peak last that you computed?

A. I suppose an hour or so.

Q. Don't you know?

A. Well, let us see if it was, then.

Q. No, we won't 'just let us see', you either know or you do not know. If you know, tell me.

A. No, I don't know exactly.

Q. You do not know?

A. No, sir."

The figure for Chattanooga of 459,000 second feet is for the 1867 flood as computed by the TVA. The records for that flood are not good and it was necessary for us to compute them as best we could. Our flood control unit computed that figure. I think they did it by extensions of existing rating curves. I am not exactly positive as to how they got that figure. As to whether we have shown as the maximum for Chattanooga is a computation that someone has made in a case where there were no gauge heights and no records of what the discharge was, there is a record of the high water marks, with no record of the actual discharge. [fol. 1423-a] I do not know whether it is right or not that the record we used was a record of the kind Mr. Kimball told about where some old gentleman made a mark on a building and then a photographer took a picture four miles away as shown on the exhibit which Mr. Kimball offered in evidence. I would like to point out that the purpose of this exhibit here is to show that there is a very great fluctuation between maximum and minimum discharge. I would [fol. 1424] be perfectly willing to take the discharge as recorded by the Geological Survey if that would be any better. As to whether we could have taken the records of the Geological Survey instead of calculating some higher ones, the records of the Geological Survey would show a very great fluctuation, practically the same thing, and I would be willing to substitute them.

For Knoxville I show a maximum of 290,000 second feet. I testified in the Ashwander case as follows:

"A. Second feet. That means cubic feet of water per second. At Knoxville, Tennessee, the flood has been up around, I believe, 195,000 second feet. So there is a very great variation in the flow in the low water season in the summer and the high water flow in the winter."

I think I was considerably short in that answer, though. I was answering very approximately. I am not sure from my studies that it is exactly right to say that the maximum flow shown at Knoxville by the U. S. Geological Survey is 195,000 second feet. I would have to look it up. It is not exactly right that one of the maximum and minimum flows on Defendants' Exhibit 94 have been computed by me, the maximum much higher and the minimum very substantially lower than that shown by the U. S. Geological Survey and the Corps of Engineers. The maximums are somewhat higher than the record shown by the Geological Survey. I think you will find all the minimum flows in Bulletin 40, "Surface Waters of Tennessee". I testified in the Ashwander case that during the summer months the stream flow runs as low as about eight thousand to ten thousand second feet. That is the average low water flow in a typical dry season. Bulletin 40 on the "Surface Waters of Tennessee" gives this minimum flow at Florence of 4,000 second feet corresponding to Defendants' Exhibit 94, but I do not have that with me. It is not U. S. G. S. Bulletin 40. It was published by the State of Tennessee. It combines the records of U. S. G. S. in Bulletin 40. As to whether I can give a reference to any U. S. G. S. publication which gives any of the maximum figures shown on Defendants' Exhibit 94, I could refer you to Bulletin 40 for the maximum stages. There is no bulletin of the U. S. G. S. that gives the maximum discharges shown on the exhibit. It gives the stages. I could not exactly get those figures by applying any rating curve of the U. S. Geological Survey to any data in the U. S. Geological Survey Bulletins. You could get them approximately.

Defendants' Exhibit 95, "Previous Projects, Tennessee River Basin", shows a navigation channel on the Duck River three feet deep for six months of the year. As I recall it, that project was to extend up the Duck River to Columbia, Tennessee. It is a fact that all the work that was ever done on that project was completed in 1883 and that it

was abandoned years and years ago. As to whether it is a fact that there has not been any commerce there for many years if ever, I think there has been some commerce on the Duck River. I don't think there was any in 1935.

I don't know the distance offhand of the project on the Elk River that I show for clearing and snagging. I am not sure whether there has ever been any work done on that project since 1899. I don't think any commerce was shown on that project in the Report of the Chief of Engineers for 1935.

I think that some work has been done on the Hiwassee River project since 1915. I don't know the exact date, but as I recall it, the work ran beyond that point. I will try to check it and give you authority for that statement out of the Chief's Report. If the Report of the Chief of Engineers says that the last commerce that was moving on the Hiwassee River was 53 tons in 1934, it is a fact.

I imagine that it is true that there has not been any work done on the so-called project on the Little Tennessee River since 1913. It may be true that there has not been a ton of commerce, even logs, moving on it since 1926.

[fol. 1426] I do not know whether it is true that there has not been any work done on the project on the Holston River since 1908. I would not want to testify that there had been. As to whether it is true that there is no commerce on that so-called project whatever according to the Chief's Report, there is sand and gravel moving out of the lower end of the Holston River. The Chief's Report probably reported that as being on the Tennessee River at Knoxville. I don't claim that there is any commerce shown in the Report of the Chief of Engineers as moving on the Holston River.

It is true that there has not been any work done on the project on the French Broad River since 1923. It is a lot further than 2½ miles up to Leadville. 68 miles is more like it. It is true at the present time that the only commerce that there is there is at this lower end, a little sand and gravel which is carried into Knoxville. In connection with all this, I would like to refer to p. 218 of House Document 328, which is a table showing the head of past navigation on the tributaries of the Tennessee River. It shows that navigation has proceeded very substantial distances up all these streams.

I also show on Defendants' Exhibit 95 the total expenditures on the Tennessee River to June 30, 1934 of \$25,297,-468.03, exclusive of Wilson Dam. The report of the Chief of Engineers for 1934, Vol. 1, shows the total expenditures on the Tennessee River for all navigation purposes, except for operating and care of canals, locks and dams and except for expenditures on the Wilson Dam, is \$18,366,-587.74. On page 908 of the same report the net total expenditures for operation and care of canals, locks and dams on the Tennessee River up to June 30, 1934 was \$2,798,000. The total figure given by the Chief of Engineers is then \$21,165,361.08 as covering all expenditures for navigation on the Tennessee River up to and including June 30, 1934, excepting for Wilson Dam. As to whether I can explain [fol. 1427] the discrepancy between my figures and the figures shown in the report of the Chief, I had a tabulation in some of my notes that showed how I obtained that and it was from the 1934 Chief's report. I don't recognize this tabulation shown here as being the one I used. The figure that I read of \$18,366,587.74 is here in this table. I did not recognize it as being the total. Page 908 shows the other figure, \$2,798,000 was the total expenditure for operation and care of locks, canals and dams. I can give a breakdown of my figure. I am afraid I do not have the notes in this book. Presently I cannot give exactly any explanation of this discrepancy. I cannot give any explanation at all, no complete explanation, of this discrepancy between my figures for this total expenditure on the Tennessee River and the figures given by the Chief of Engineers.

Referring to Defendants' Exhibit 96, we did not have an official report of the Chief of Engineers for 1937 but we do have a preliminary report. The last reading here for the year 1935 was taken from the 1936 report. The total volume of traffic shown for the year 1900 is taken from the peak of the line on the graph for that year and is about 1,455,000 tons. I read that right off the peak of the white line, the top of the line. The same figure for 1930 is 2,590,000 tons. I testified that the existing traffic prior to May, 1935, was mostly short-haul traffic, because other traffic was prevented by obstructions to navigation. In terms of tons about 70 or 80 per cent of the existing traffic consists of sand and gravel, and in terms of ton-miles, around 50 to 60 per cent. The graph shows the traffic in tons. Eighty per cent of it as shown on Defendants' Exhibit 96 is sand and gravel

tonnage. That sand and gravel tonnage would not be through traffic if we had this glorified waterway I spoke about, but there would be other commodities that would be. [fol. 1428] I never knew sand and gravel being hauled long distances in areas where sand and gravel is generally found, as in the Tennessee Valley.

Defendants' Exhibit 97, entitled "Existing and Probable Channel Depths before Tennessee Valley Authority Act," includes at the bottom the statement "Certain Tributary Channel Depths Proposed by Army Engineers in House Document 328." There is no place in the recommendation of the Chief of Engineers in House Document 328, which is Complainants' Exhibit 105, where the Chief proposes an adoption of the projects which are shown on Defendants' Exhibit 97, such as the Holston River 9 feet, the French Broad 6 feet, Nolichucky 6 feet, Little River 6 feet, Emory River 9 feet, Clinch River 9 feet, Little Tennessee River 6 feet, Hiwassee River 6 feet, Duck River 6 feet. The word "proposed" which I used on the chart I do not find in the report of the Chief of Engineers. In the report of the Board of Engineers for Rivers and Harbors appearing on pages 7 to 25 of House Document 328, it is stated on page 18, paragraph 29:

"Conclusions and recommendations of the District Engineer: The proposed comprehensive plan for the development of the Tennessee River and its tributaries provides for 9-foot navigation on the main stream on the Holston to Kingsport, and on the Clinch to Speers Ferry, and 6-foot navigation on the lower part of other tributaries."

That is one of my authorities. I do not know that that is a mere recital by the Board of Engineers of a statement made by the District Engineer. The recommendation of the Board of Engineers appears on page 24, paragraph 53 of House Document 328 and is:

"The Board is of the opinion that no further improvement of the Tennessee River above Knoxville or of the tributaries of the Tennessee River is worthy of being undertaken by the United States at the present time, either directly or by participation in the cost thereof, other than such maintenance of the existing navigation projects as may be justified from time to time."

[fol. 1429] That is not the reason why I put these projects on Defendants' Exhibit 97, but I am still sticking with what the District Engineer said. On my examination of the report I did not conclude that the statement of the District Engineer was the proposal of the Army Engineers. I did not conclude that his opinion overruled the Board of Engineers and Chief of Engineers. I do not believe it overruled them at all. The District Engineer was the man making the report and he made all the report which he certified to his superiors. I am familiar with the fact that when Congress adopts any project, it adopts the project recommended by the Chief of Engineers and in the final analysis the report of the Chief of Engineers is the controlling thing. It is not a fact that the only suggestion in House Document 328 with reference to these projects which I say were proposed by the Army Engineers in Defendants' Exhibit 97, is the suggestion of the District Engineer that when, as and if there should ever be constructed by combined public and private expense the \$1,200,000,000 plan for the development of navigation, flood control and water power on the Tennessee River and its tributaries, such developments on the tributaries of the river might be made and even the District Engineer did not recommend such a plan to be developed at public expense. I am depending upon the recommendations and conclusions of the District Engineer as I read them. The District Engineer says in his conclusions and recommendations on page 100, paragraph 80 of House Document 328:

"It is recommended that the general plan proposed for the combined development of the Tennessee River and its tributaries for navigation, power, and flood control be adopted as a general guide, subject to such modifications as may be found necessary and approved by the Chief of Engineers and Secretary of War, for navigation and flood control on the Tennessee River and its tributaries, and subject further to such modifications as may be found necessary in carrying out the provisions of the Federal water power act. It is recommended that a project for the progressive improvement of the Tennessee River from its mouth to Knoxville, by a system of movable or low fixed dams and by locks of Ohio River standards be adopted, to be completed [fol. 1430] within a period of 10 years at an estimated cost of \$75,000,000 at the rate of \$3,000,000 for the first year

and \$8,000,000 for each year thereafter until completion, with \$40,000 for annual operation, care, and maintenance of each dam and pool; with the proviso that under the provisions of the Federal water power act there may be substituted for any two or more of the low dams herein provided for, a high dam if the resulting cost to the Federal Government will be less than by the estimate herein for the low dams thus rendered unnecessary, and provided further that the capacity of the waterway for the economical movement of modern barge traffic will not be in any way lessened."

He refers here to \$75,000,000 for low dams on the main river.

In connection with Defendants' Exhibit 98, entitled "TVA Projects," I testified that each of the TVA main river dams would provide a substantial improvement in navigable conditions on the Tennessee River over those prevailing before the time of the TVA Act. Assuming that dams did not create hazards to navigation, any system of dams which provided a 9 ft. channel continuously from Paducah to Knoxville, instead of the lesser depth which prevailed in the state of the limited improvement of the Tennessee River previously existing, would be a substantial improvement to navigation. I would not say any series of dams would provide an excellent navigable waterway.

The elevation of the upper sill at Wilson Lock is 493.06. If Wilson pool is held to 503, there would be 10 feet of depth over the sill, if what you have known as low pool elevation would be maintained. I think what we consider as low pool elevation at Wilson Dam is 503 which would be about 10 feet. The elevation at the intermediate sill at Wilson Lock would just depend on how the chambers are operated. The elevation of the middle sill is 450.14 feet and those chambers can be operated to get slightly more than 9 feet over that middle sill. Just a little more. I am sure we can get more than 9 feet over that sill.

* It is true that the stretch between Chattanooga and [fol.1431] Knoxville is the most unfavorable from the standpoint of navigation under present conditions, if you are referring only to channel depths, because the controlling depth at low water is only about one foot. That practically precludes any commercial navigation at extreme low water. Knoxville and Chattanooga are the two largest cities on

the Tennessee River. It is not at all unusual in developing a river, where the primary purpose is navigation, first to provide channels between the two largest cities and two largest potential centers of commerce. The two largest cities might not need anything. If you look at it the other way, the traffic has to be between Chattanooga and the Ohio River.

"Q. Of course, if you assume you will not have any traffic between your largest cities, and largest potential centers of commerce, I should think that would be all right. But laying aside any unique, and, so far as I know, any unheard of situation of that character, is it not true in developing a waterway for navigation, is it not customary first to connect that stretch of water which connects the two largest centers of commerce and the two largest centers of potential traffic?

A. You are assuming the two largest centers of potential traffic will be Knoxville and Chattanooga. I do not believe that is true.

Q. I am not talking anything about Chattanooga or Knoxville at all, so if you will answer that question directly, please.

A. I would say no, it is not customary, because every project is an entity in itself, and it might be quite desirable on any stream to develop the lower part of it first so that you will be able to go somewhere on that stream."

I do not take the position that and it is not my advice that the very last thing you do will be to improve the part of the waterway which connects the principal sources of potential water commerce. It might be true that the principal water commerce on the Ohio has been between Cincinnati and the Youngstown and Pittsburgh area. I would not be sure. I am quite familiar with the inland waterway [fol. 1432] commerce in the United States, but I have not checked up on that particular table for sometime, but I think there is substantial commerce. I do not know that it is a fact either that the Ohio River was first improved between Pittsburgh and Cincinnati or, if so, that it was because those were the two largest sources of potential water traffic. I would not be sure that the dams were first built on the Ohio from Pittsburgh down to Cincinnati. That

was started sometime ago and I have not checked up on it.

As to my opinion that a river should be developed from the mouth up, the TVA has not developed its 9 ft. channel from Paducah up the next 200 miles. Anyway it has developed the first very difficult section from the mouth. It has developed a section between Pickwick and Wilson and a section above Wilson Lake up to Guntersville, Alabama. I testified in the Ashwander case and the following questions were asked me and I made the following answers:

"Q. Well, the figures that were read here immediately before recess indicate a very much larger tonnage, potential tonnage for the use of the river north of Chattanooga, as I recall the figures. Is that in accordance with your understanding or report in connection with the matter?

A. In the ultimate development probably that would be true.

Q. And you are doing nothing with respect to the actual or practical navigation on that stretch of the river between Chattanooga and Knoxville under the existing program?

A. Well, I have reported on that matter and written memorandums concerning it, not feasible.

Q. Not feasible to improve navigation north of Chattanooga on the river?

A. Well, not as an immediate proposition.

Q. What is that?

A. Not as an immediate project.

Q. Not feasible. Do you mean the dams cannot be constructed that will improve it?

A. They could be."

[fol. 1433] I want to point out that our program has advanced considerably beyond that point, and that the Chickamauga Dam is now under construction by the TVA, which is the first length in the improvement of the channel from Chattanooga toward Knoxville. I do not want to testify that Chickamauga Dam would make it possible to develop this large potential commerce between Chattanooga and Knoxville, but it is the first essential step in the development of that potential commerce. As to whether they ignored my recommendation about it not being feasible, I said not feasible as an immediate proposition. Two years have elapsed since that testimony was taken and probably more years since that report was written. Any change that

has occurred in the intervening two years would not to my knowledge have been in the desire for the development of power. As to whether they always wanted that, I cannot give any answer to that. I am working on the navigation features, and the Chickamauga Dam is certainly an improvement of the navigation channel.

As to whether I testified yesterday that I had studied economical lock sizes and that I had concluded that Florence was such an important commercial center that it would require locks 110x600 feet in conformity with the navigation developments of the Corps of Engineers on the Ohio and Mississippi Rivers, I don't think I made the statement on the ground that Florence, Alabama, was at the present time, such a large and important industrial center. I did state that the Muscle Shoals area was potentially an important commercial and industrial center and that I thought that was one reason why the large locks should be provided between that point and the mouth of the river. I testified that: "I made considerable study of economical lock size on the Tennessee River and I concluded that the area around Florence, Alabama, was an important industrial area and had considerable potentialities, and that it would be reasonable to have the large locks to carry navigation up that [fol. 1434] far." I did not conclude in my study that Chattanooga and Knoxville were relatively so insignificant as commercial and manufacturing centers in comparison with Florence, that locks comparable in size to those for the river below Florence would not be justified. I concluded that because we had the small locks in the middle section of the river between Florence and Chattanooga, as an initial proposition it would not be worth while to put large locks at Chattanooga and Knoxville. However, we have provided space for large locks at Chickamauga, and will provide space for the large lock at Watts Bar and Coulter Shoals so that these large locks can be built parallel to the small locks if the time ever arises when it would be economical to do so.

There are no public terminal facilities at Florence, Alabama. There are some private terminal facilities in the Florence Canal right behind Lock and Dam No. 1. In order to get to those facilities, you have to go through Lock and Dam No. 1. The lock at Dam No. 1 is 60 by 300 feet. It was an existing lock built by the Corps of Engineers before

the TVA started on this new program of lock sizes. There has been no change in the size of that lock as yet. No new large lock is under construction. I testified that there was provision made for constructing locks 110 ft. by 600 ft. in the dams above Wilson, I did not mean to include Norris or Hiwassee Dams in that.

We received a letter from General Markham of the Corps of Engineers in regard to the lock sizes to show that the navigation facilities were approved by the Chief of Engineers. It is a fact that whenever a private power company builds a power dam and reservoir on a navigable stream, under a license from the Federal Water Power Commission, [fol. 1435] all the navigation facilities are approved by the Chief of Engineers. We did not do any less here than a private power company would do, about the same thing I should think, in the matter of consulting with the Chief of Engineers and getting his approval.

Defendants' Exhibit 99 shows a steamer in one of the large locks, 110 by 600 ft. Defendants' Exhibit 100 shows some barges in the small lock at Wheeler Dam. They are [fol. 1436] cement barges hauling material for the TVA, and that particular towboat and barges are part of the line operated by Colonel Willson who testified in this case. Substantial amounts of sand, gravel, cement, machinery and steel in the total traffic on the Tennessee River during the calendar year 1936 resulted from the movements of material and equipment for the construction work of the TVA. I don't have that figure. I would not be sure that it is true that the increase in the water traffic, if any, on the Tennessee River during the calendar year 1936 over that in 1935 was largely, if not wholly, due to the construction operations of the TVA. I think the TVA traffic had a good deal to do with that increase. It would be fair to say that about the only additional traffic attracted to the Tennessee River by the low water releases from Norris Dam in 1936 is that involved in supplying the material, machinery and equipment for the TVA construction operations. I believe there will be a different story later on.

I testified that in my opinion low water regulation by Norris and Hiwassee Dams in a low water year would produce a minimum flow of 18,000 second feet below Wilson and increase the controlling depth below Pickwick from $4\frac{1}{2}$ to $7\frac{1}{2}$ feet. As to whether I testified that it might be 5 or 6 years before the Gilbertsville Dam would be completed, I

think that is a short period. It may be eight or ten years or almost any period. It is very indefinite.

"Q. Now, if work had been commenced in 1933, would it not have been practicable to have completed a nine foot channel under the low dam plan from Paducah to Knoxville by the present time with the amount of money which was spent by TVA only at Wheeler and Norris?"

A. Well, under your assumption, if it had been started in 1933. I think there is not the vaguest possibility that it would have been started in 1933 or any other year.

Q. If you will just not worry about that—is the answer 'Yes' to my question on the assumptions I made?

A. The answer is 'Yes' on your assumptions."

[fol. 1437] I do not know exactly what the low water flow in 1936 at Florence was without releases from Norris Dam. The official reports do not show the natural flow without the Norris releases because the Norris releases were in the flows at Florence at that time. The best way I could compute it was to check the average releases by weeks from Norris reservoir for 1936, and I computed that the maximum weekly releases in terms of second feet was 7,400 cubic feet per second for 1936, and that would be the average daily release throughout that week. According to the records of the Geological Survey which maintains a gauge at Florence, they show a minimum flow of 8,230 cubic feet per second occurring on August 16, 1936. That was an extremely low flow, which was produced by the running of a flow experiment down there at the request of the Army Engineers, and for three days we cut off the Norris releases. That would be the absolutely minimum flow at Florence for that period. The corresponding figure for 1937 was on July 21, 1937, 6,420 cubic feet per second, which was the low flow produced when we cut off the Norris pool in order to work on the cofferdam at Pickwick. Without the benefits of any releases from Norris, the extreme low flow in 1936 of 8,230 cubic feet per second would have produced a depth below Pickwick Landing of about 4½ feet. That low flow was for two days. Then one more day that was increased up to about 12,000.

As to what depth would generally have been available during the low water season below Pickwick without any releases from Norris, the smallest release that we made

from Norris was an average of only 100 second feet in the week starting July 15. That would be deductible from the natural discharge averaging around 20,000 down there. Since that discharge was so high, the Norris release was correspondingly small. As to what would have been in [fol. 1438] general the depth below Pickwick without any Norris releases in 1936 and 1937 throughout what the engineers call the low water season on a navigable stream, I think it would have gotten down around what 4½ feet I quoted. It would not have continued at that throughout the low water season. It never continues throughout, but for a substantial time.

A 9 foot channel below Pickwick Landing prior to the construction of Gilbertsville Dam will be available from the highest flows during the winter season. There would be a 9 foot depth through a narrow channel width, about 100 feet wide, 70 per cent of the time. The increased current velocities at the head of each of the high dam pools resulting from the increased regulated low water flow would be about 2½ miles per hour. I stated that after the completion of these high dams on the Tennessee River, the operation of Norris and Hiwassee would permit flexible operation for multiple purposes. Using less obscure and elegant language, that does not necessarily mean it would permit manipulation for power production. It would permit manipulation for flood control, and that would be the very important reason for drawing the reservoirs way down. That is, not for drawing down reservoirs like Hiwassee and Norris, but for drawing main stream pools down. As to whether it would permit manipulation for power purposes, that would all be a question of operation. I know it would, if you wanted to use it that way. That would all depend upon the rules of operation. The upstream storage would also help in permitting daily peaking operations for meeting a daily utility load curve, but that would not have anything to do with the value of the increased depth in the main stream pools. If we used our pondage in the main stream pools for peaking for power purposes, we would need to have some way of replenishing it if we draw down too low.

[fol. 1439] The table (offered and received in evidence as Complainants' Exhibit 916) is based on the daily river bulletins of the TVA, identified as Complainants' Exhibit

910, and shows it to be a fact that during 1936 the flow was cut off entirely at Norris during August and up to and including October 4th on each Sunday and on Labor Day. There is no special advantage to navigation during low water seasons in shutting off water on Sundays and Labor Day, but, of course, the navigation improvement was below Wilson Dam and releases from accumulated water in Wilson Dam were made regardless of these shut-offs at Norris Dam over the week-end. I do not want to testify that these shut-offs at Norris Dam over the week-ends and on Labor Day were made for navigation purposes. I do not know whether they were made for power purposes. I would not know anything about that. The navigation was taken care of by the Wilson releases over the week-end because there was enough accumulated water to do that. I am very sure about that. The official records of the Florence gauge show that.

Defendants' Exhibits 102 and 103 purport to show plans for a coal conveyor at Norris Dam and each of these exhibits is dated September 21, 1937. Some such plans and tracings had been made before September of 1937. We had given considerable consideration to this and some preliminary sketches had been made. As to why I did not produce the official plans, if there are any, that were prepared by TVA for coal conveyors over Norris Dam, these are as official as any we have. As to whether I have any earlier plans that had been prepared, we had been studying this matter for some years. As to my willingness to produce any earlier plan, if I have it, I have no earlier plan than these which are dated September 21, 1937, which is drawn up in any understandable fashion. As to whether these two drawings dated September 21, 1937, are the first drawings that were ever made by TVA for this purpose, [fol. 1440] these two drawings are the first ones made completely and in a nice shape, but that does not mean that this was the first time we had seriously considered the matter. I testified in the Ashwander case and was asked the following questions and made the following answers:

"Q. Very well, then. Have the plans as to the making, providing for navigation through Norris Dam, reached the point of any final and definite study and recommendation?

A. No.

Q. You gave as your reason that it was—did you not, that it was so far in the future before any tonnage will move through there that it was not considered necessary to reach a final decision, to make provision now, or have you got a study now, for that?

A. That is the governing consideration, as I see it.

Q. And so far as the present plan is concerned, navigation has not been considered in the design of the Norris Dam, navigation through, navigation of the Clinch River above Norris has not been considered?

A. Oh, it has been considered as an ultimate proposition; yes.

Q. But has not approved existing plan or project?

A. Only we know what we could do when the times comes to do it.

Q. There have been representatives of the Tennessee Valley Authority, in the last few days, going around this district to ascertain about the question of coal conveyors, have there not?

A. Yes."

That was two and one-half years ago, so there is at least two and one-half years that we have been studying it and we had been studying it some time before that. It is an unfair implication in those questions that the fact is we had just started scurrying around and finding out about coal conveyors at the time the testimony was going in in [fol. 1441] the Ashwander case. I do not know that I corrected it at that time. I would not say that this is the first time since this going around about coal conveyors at the time of the Ashwander case that we have prepared anything definite, because in the construction of Norris Dam, we actually left a tunnel through there for the coal conveyor. We certainly gave serious consideration on that because it is there. As to whether we made provision for the tunnel after the testimony in the Ashwander case, well, of course, the construction had progressed to that point only after the Ashwander case. As to whether it is a fact that we incorporated the tunnel for the conveyor in the Norris Dam after our experience in the Ashwander case, I think it came after that, but that still would not indicate it was a new idea with us.

I never had any personal experience directly in the operation of coal conveyors over dams. I have made a study

of it and am convinced it can be done. I know of no coal conveyors similar to the one shown on Defendants' Exhibits 102 and 103, in operation over any dam in the United States. Some coal conveyors are in operation on the Monongahela River, which are quite ingenious and are fully as difficult as this one. Those are simply loading and unloading devices which are in use on the Monongahela River and the Great Lakes. This is the same thing.

Examination by the Court:

This coal conveyor would be somewhat similar to the usual tramway of a mine, the coal would be loaded on an endless belt and the belt would convey the coal to its destination.

Cross-examination continued:

As to whether I mean an ordinary tramway in a mine is an endless belt, I do not know that I understand the question, [fol. 1442] but there are mines that have endless belts leading out of them. I do not know the definition of a tramway.

Examination by the Court:

As to whether it is a fact such a contraption as shown in Defendants' Exhibits 102 and 103 is contemplated at Norris Dam, I would say that that would be installed if traffic conditions warranted it. As to whether I anticipate such traffic conditions would ever arise to warrant it, I think they would if the lower Clinch River is canalized. I think the lower Clinch River will eventually be canalized. As to where the water will come from, there will be enough water for the locks and dams from Norris Dam, only a minor amount of water will be needed.

Cross-examination continued:

This belt conveyor is about 3 feet wide and is about 300 feet long between the barge and the tunnel through the dam. On Defendants' Exhibit 103 the belt conveyor is shown to be operating at a 30 degree angle to the horizontal. I could not recite any belt conveyor offhand which is used for handling coal at any angle as great as that, but I think it could be done. As to whether it is a fact

that at such an angle the coal would constantly roll down the belt, would be very inefficient and at the same time tend to degradation, we could make a flight conveyor with baffles to keep it from rolling if that is necessary. As to that not being what we have done, I am not sure of the detail, but it can be worked out. The tunnel through the dam is somewhere around an elevation of 1,025 or 1,030. It may be higher than that. It scales on this exhibit somewhere around 1,035 or 1,040. When the coal is turned loose near the top of the dam on the downstream side, it would roll to the bottom of the bin, sliding down the face of the dam about 150 feet. As to what will happen to the coal sliding [fol. 1443] down that 150 or 200 feet, it will be crushed to some extent, but I do not think that will hurt much. They powder coal now, it is excellent for industrial uses. I do not think that will decrease the value of the coal for industrial uses. It might for special purposes. As to what will happen to the coal barges when the spillway is in operation at extreme flood, there will be some danger there, and they might not be able to operate the coal conveyor, but I suppose 95% of the year they could.

The barges at the upper ends of the Clinch or Powell Rivers could be loaded through chutes at low pool stages. During the high water stages they could be loaded through the same chutes, with some adjustments. The chute would be from 80 to 100 feet long.

Under present conditions the barges shown on Defendants' Exhibit 102 would have to be shipped by land transport to get them above the dam, but not below the dam. This whole thing is predicated on the canalization of the Clinch River. Under present conditions there is no way to get the barges below the dam or to take them away after they were loaded, they would not want to. They would be grounded long before they were loaded. There is nothing provided in the TVA Unified Plan to get the barges down below the dam or get them away. I have made some estimates as to the cost of getting the barges loaded, as well as getting them away and including the cost of degradation of coal. I estimated that the conveyor could handle the coal at 16½ cents a ton, including fixed and operating charges on the conveyor installation, and fixed charges on the floating equipment that would be left above

the dam, that is, the barges and towboat that would be necessary above the dam.

[fol. 1444] Examination by the Court:

There are large deposits of coal on the upper Clinch within a short distance from the north side of the Clinch River. The larger fields now are available to railroads. There are considerable areas of undeveloped fields or of fields developed in a small way that are not available to railroads.

Cross-examination continued:

With the water at the elevation I have shown on Defendants' Exhibit 103, there would have to be some short land transfer from the larger coal mines to the pool. The larger developed fields are over 25 miles from the pool, if the pool is at the elevation shown on Defendants' Exhibit 103.

As to how this belt conveyor would operate on the transportation of the large deposits of marble in and about Norris Lake, I do not understand that there are any large deposits of marble in and around Norris Lake. It is not contemplated that this conveyor arrangement could be used for the movement of marble. We believe that the marble movement would be a minor matter. We all agree that we could not move marble on this conveyor.

When the pool is at maximum level, the cargo barge and the wharf barge would float right up with the pool and the tunnel through the dam would stay right where it is. The tunnel would not be full of water, as it is high enough so that it would take a tremendous flood with Norris reservoir away up to the roadway to flood through it. As to whether the scale shows the tunnel to be at elevation 1031, I thought we said 1035 or 1040. I think it is between elevation 1035 and 1040. As to whether it is my testimony that the pool will never be any higher than that, the pool might be higher than that on rare occasions in which cases we just would not operate the coal conveyor.

[fol. 1445] Defendants' Exhibit 104, entitled "Comparison of high dam and low dam plans on the Tennessee River", is distorted as to the horizontal scale. As to whether the distortion is 3500 to 1, I do not know what the distortion is. I used such an extreme distortion for the purpose of showing the comparison of these plans so as to get it on a

reasonable sized chart. The original is on one of those cards on the stand. That was as large a card as will go on the stand. I have shown it on Defendants' Exhibit 98 with much less distortion. That was the one that had Norris and Hiwassee superimposed up in the upper right hand side. We had to leave space to get those in. As to whether we could not distort it as much as we distorted it in Defendants' Exhibit 104, we had to have the space to get the rest of the drawing on Defendants' Exhibit 98. I do not know that Defendants' Exhibit 98 presents a different picture. Defendants' Exhibit 104 shows the true situation of the high and low dams, but it is true that it also shows it with a much more highly distorted scale than Exhibit 98.

On Defendants' Exhibit 105 entitled "Time Saved in Lockages with TVA High Plan", the words "Assuming same size of locks any plan", in different kind and size of type, were added to the title by me almost immediately after preparing the table, because I did not think it was clear without that. I made that table just recently.

"Q. Isn't it a fact that the low dam navigation plan, set forth in House Document 328, and incorporated in the Rivers and Harbors Act of July 3, 1930, provides for locks 110 by 600 feet except at Wilson, Dam No. 1, and Hale's Bar Dam, which were already in existence and common to any plan of improvement?

A. Yes, that is right.

Q. Why, then, did you prepare an exhibit purporting to compare the time saved on lockages upon an assumption of the same size of locks in each plan?

A. Well, if the tow was of a size that it could go through in a single lockage, it would really make no difference as to the size of the locks in the two plans.

[fol. 1446] Q. When you added to your exhibit 105 the words 'Assuming the same size of locks in each plan,' and referred it to the low dam plan, you knew that was not true, did you not?

A. Well, now, we have discussed the fact that the large locks can be put in the high dam plan, so, as an ultimate comparison, I think it is perfectly fair to assume the same size of locks in each plan.

Q. You knew, as a matter of fact, when you prepared exhibit 105, that the low dam plan adopted by the Rivers &

Harbors Act of July 3, 1930, provided for locks 110 by 600 feet throughout, didn't you?

A. That is right, and I knew that we could supply such size locks in the high dam plan whenever it became feasible.

Q. And you also knew, when you prepared defendants' Exhibit 105, that the TVA Unified Plan, as far as it has been constructed, and as far as it has been planned for construction, above Wilson Dam, does not provide locks 110 by 600 feet, did you not?

A. That is true, as far as it has been constructed, and as far as plans for construction, but there is a possibility there for putting in the large locks, and I think that should be kept in mind right along.

Judge Allen: Do you make your comparison here with the so-called low dam plan in House Document 328 or a hypothetical low dam plan?

The Witness: It is the same number of locks and dams as in the House Document plan, but if you want to assume that the large locks are in the low dam system, why, then, I assume that the large locks would be in the high dam system as an alternate matter, so that the comparison is made on the basis of the same size of locks.

By R. T. Jackson:

Q. Mr. Barker, in view of your counsel's suggestion, I direct your attention to the title 'Time Saved in Lockages with TVA High Dam Plan.' Now, does that mean the plan that is being constructed, or some other plan?

A. Well, it means the plan as constructed or contemplated.

Q. Yes. And then, 'As Compared to a Low Dam Plan,' did you mean the low dam plan adopted by the Rivers and Harbors Act of July 3, 1930, or not?

A. Yes, it is the same plan.

Q. You meant that?

A. Yes.

[fol. 1447] Q. Now, if you did mean that, you knew that any representation that it would have locks less than 110 by 600 feet was untrue, did you not?

A. Do I say that there? I don't see that I do.

Q. Do you say—will you point out where you show on exhibit 105 that you have altered the low dam plan set forth

in the House Document 328 so as to provide small locks instead of the locks 110 by 600?

A. I don't even say that now.

Q. Well, point out anything that shows that to anyone on the face of the exhibit.

A. It does not show it on the exhibit and I don't say it now.

Q. Now you show down here on the lower part of the exhibit, 'Time consumed in lockages, double lockages above Florence, Alabama,' don't you?

A. That is right.

Q. Now, why would you have double lockages above Florence, Alabama, if the low dam plan was constructed as adopted by the Congress in the Act of July 3, 1930?

A. You would not. This is for the purposes of comparison with just the title as shown.

Q. But it is not for any purpose of comparison, then, between the low dam plan as adopted by the Congress in the Act of July 3, 1930, and the TVA Unified Plan as it is being constructed?

A. The low dam plan shown in House Document 328 has two sets of costs, one with the small locks, and one with the large. I thought it would be of interest to make the comparison with the small locks in the House Document.

Q. And did you think it would be of interest to make a comparison with the small locks because the Chief of Engineers had recommended the project with the large locks and the Congress had adopted a project with the large locks?

A. Why, that had nothing to do with it.

Q. Is there anything on this exhibit to show that you are not purporting to compare on the face of the exhibit the TVA Unified Plan, as it is being constructed, and the low dam navigation plan as it was authorized by the Congress in the Act of July 3, 1930?

A. I don't think there is anything on the exhibit that would show that.

[fol. 1448] Q. The fact is, if you took the low dam navigation program as it was authorized by the Congress and adopted by the Congress in the Act of July 3, 1930, and compared it with the TVA Unified Plan, so far as it has been constructed and is presently planned to be constructed, the conclusions that show on exhibit 105 will be completely in error, will they not?

A. If the large locks were not in the TVA scheme then we would want a further computation on the exhibit.

Q. Are you in any doubt as to whether there are large locks at Wheeler?

A. Oh, not existing.

Q. Are you in any doubt as to whether there are large locks at Guntersville?

A. Not existing.

Q. No. Are you in any doubt as to whether there are incorporated in the construction plans, locks 600 feet long at Coulter Shoals and Watts Bar?

A. Well, the space will be provided.

Q. Well, the whole river is going to be there, yes, but you know what I mean Mr. Barker, and you know that there are no construction plans providing for the construction of locks of that size, when and as those dams and pools are constructed, are there?

A. Not in the initial plans, no large locks."

Examination by the Court:

As to whether I as an engineer can make a comparison of time saved in lockages between the TVA high dam plan and any low dam plan unless I assumed the same size of locks in each plan, it could be done. I did not think that was the fair way to do it in view of the fact that we can and will provide the large locks when that traffic warrants.

"Judge Gore: I wonder, if you could make an exhibit, Mr. Jackson, based upon the size of the locks as contemplated by the Act of Congress in the low dam plan, and then let us see what the difference would be? Is such an exhibit in the record?

Mr. Jackson: We will put one in, your Honor.

Judge Gore: I see; all right."

[fol. 1449] A tow boat and eight standard Ohio River barges can go through a lock 600 feet long without breaking tow. I think it is true that a tow boat with eight such barges cannot go through a lock 60 feet by 300 or 360 feet without breaking tow three times. An eight barge tow with standard equipment would be a very large tow. I do not think we would get so many of those to start with on the Tennessee River. As to whether that is the practicable and economical sized tow used on 9 foot channels such as the

Ohio River, there are tows like that used. I did not hear Colonel Watkins' testimony about the usual tows of 250 or 300 railroad cars equivalent. It is a fact that with such a tow of eight barges you would have to take four barges through separately and the tow boat through another time. You could not take more than four barges through at once if you had a tow that size and if you had eight barges you would still have to get your tow boat through. That would be true even if you had towing machinery for pulling the barges up through the lock. There is no question about it.

In Defendants' Exhibit 105 I did not make any allowance for time saved in the low dam plan by reason of the use of the navigable passes.

In my estimates of costs of operation and maintenance for the low dam plan and for the TVA plan, I included Dam No. 1, Florence Canal and Wilson Dam. In the Ashwander case I testified that the saving in maintenance and operation of the locks and dams under the TVA plan would amount to \$1,065,000 annually as against the low dam plan and I stated that I had not calculated in terms of money the saving in dredging costs. I testified in this case that there was a saving in favor of the TVA plan of \$1,200,000 annually. In explaining that difference between my testimony here and in the Ashwander case, in the intervening two and one-half years I had done considerably more studying and figuring [fol. 1450] on the low dams. To some extent I had been working on the low dams in the intervening two and one-half years and I used slightly different unit costs.

I estimated the cost of maintenance and operation of the main river dams of the Tennessee Valley project to be \$590,000 a year. In the First Deficiency Appropriations Bill for the TVA for 1936, in which the estimate is given of the cost of maintenance and operation of the main river dams of the TVA, it amounted to \$911,000. As to why there was a difference, I don't know for sure whether those two estimates include the same items.

As to whether I testified yesterday to the effect that the annual operation and maintenance cost would be \$40,000 for each low lift lock and dam, on looking at my detailed figures, I find that it is not as easy as that, to take just one average figure for the whole thing. I have used anywhere from \$20,000 to \$50,000 for operation and main-

tenance depending upon the type of dam, its location and just what its characteristics were. I testified yesterday that:

"I think that the operation of the low dams should be increased over what Major Putnam had. I estimate for a low lift lock and dam about \$40,000 per dam."

It is not as simple as that. That \$40,000 is not an average. I used that in some cases, but, as I say, in looking at my detailed figures, which I did not have before me yesterday, I varied from about \$20,000 to about \$50,000 per low lift lock and dam. As to whether my estimate of \$40,000 is untrue or not, I think it should be amplified by what I have stated. It is true as far as it went, it being just a rough figure. It is not necessarily my best judgment of the average figure.

"Q. What did you mean when you undertake to tell the Court it was 40,000?"

[fol. 1451] Mr. Fitts: May it please the Court, it seems to me this is purely argumentative. The witness has explained.

Judge Allen: Objection sustained. The witness has answered and explained.

Mr. R. T. Jackson: May I have an exception. I do not think he has explained.

Judge Allen: You may have your exception."

Defendants' Exhibit 109 purports to show the navigable channels of nine feet provided in certain tributaries of the Tennessee by the completion of the TVA Unified Plan, and that the channel will go approximately 12 miles up the Duck River. There are no towns within the 12 miles so far as I know. As to whether it is a fact that that 12 miles is through what is called the "Big Bottom", where there is not even a tenant house, it is through what is called the "Big Bottom", but I understand those are very good farming lands. As to whether there was even a tenant house, I am not sure about the density of population or number of houses. I would not suppose that the end of the 12 mile stretch on the Duck River is 200 miles from the phosphate fields, but I would suppose that it was 100 to 150 miles from them. I do not think it is true that it would be a great deal closer to go from the phosphate

fields to the main Tennessee River, than it would be to find the 12 mile stretch at the mouth of the Duck River. In any case, if you wanted water transportation, which would be the cheapest transportation, it would be best to take it down by river. As to whether if you had to go 150 miles by land to get to this 12 miles on the Duck River and you could get to this fine waterway, I am talking about on the Tennessee River in 20 miles, the latter route would be cheaper, I am not saying this 12 miles on the Duck River would take us to the phosphate fields. I say it is a worth-[fol. 1452] while initial step in getting the channel up Duck River to the phosphate fields. Standing by itself as it is now, that 12 mile channel does not reach any town, industry or source of commerce.

It is a fact that there are no large towns on the Elk River within the area indicated on the exhibit. The largest town there would have 100 people. I cannot name any town there, but I think there are some very small towns along that lower section of the Elk. There is a phosphate deposit alongside of the upper end of the slack water in the Elk River. I think there is some operation from it. I do not think it is a fact that from the only phosphate fields in operation in the vicinity of Elk River, it is closer to haul to the Tennessee than to the Elk. I have looked it up on the maps several times and it is my impression that those deposits are a good deal closer to the lower part of the Elk River than to the Tennessee River. There are no towns at all on Bear Creek so far as I know. The largest town on my channel on the Hiwassee River is Charleston, which I suppose has two or three thousand people. Calhoun is right across the river. As to whether it is a fact that Charleston has only two or three hundred, I may be in error. I think it has a larger population than 280. I have been there many times. Calhoun is right opposite Charleston and it is of some additional population. They are not large places but both towns are on the main line of the Southern Railroad and the main highway, so it is a very logical re-shipping point. The largest town on the slack water channel I show on the Little River is Rockford which is a very small town, with a spinning mill and a little industry. The Elk River phosphate deposits are fairly substantial, but I do not think there are any large industries on the Duck River, Bear Creek, Hiwassee or Little River. I am [fol. 1453] not sure that I have seen any of the Elk River

deposits, but I have seen them outlined on an official map of the Department. From my recollection of the mineral deposit map, I think the phosphate fields are on the west side of Elk River about the vicinity of the state line.

"Q. Mr. Barker, isn't it a fact that what is being done here is merely extending the backwater up certain of these tributaries in such a fashion as to increase the total length of the shore line on these lakes, rather than reach industrial centers with the navigable channel; and further to increase the amount of shore line that has to be maintained and possibly protected by rip rap?

A. This backwater from the main stream dams would increase the shore line, but that certainly is not the purpose of it. The slack water as developed on the tributaries as shown on the map, would form useful initial steps in developing tributaries for navigation."

The backwater is not the purpose but the result of what is being done on the main stream, a beneficial and useful result. As to whether this depends upon towns and industries being constructed there that would need it, throughout the length of the tributary somewhere there are potentialities.

The source of my material on Defendants' Exhibit 107 was all obtained from House Document 857, 63rd Congress, Second Session, and House Document 108, 67th Congress, First Session. Those documents covered data that was accumulated by the Board of Army Engineers which was making experiments on towboats. It was called the experimental towboat report. The Board of Army Engineers had a number of towboats and barges and operated them in various depths of water and accumulated data in that way. That information contained in those reports was issued February 20, 1914 and March 2, 1921. I have heard of what the Taylor formula is with relation to the general depth of water, draft and size of the tow. I could not give it offhand and I do not believe any engineer could either. [fol. 1454] In my studies I have examined a formula of that kind but I cannot identify that particular one. I did not study it in preparation of this exhibit or in preparing to testify in this case and I made no calculation of my own through the use of that formula. I think it is one of the

formulas by which scientific determinations may be made in this field. There are a good many of them. I cannot recite any other formulas for towboats, but it is a very broad subject. On being asked to name just one, offhand I cannot name one. I have heard of the second supplementary report on the investigation of the experimental board on towboats, but I do not know when it was issued. It followed these two. If you tell me it was issued in 1929, I would think that was about right. I did not use any findings of that later report in preparing my exhibit or preparing my testimony. I did not make much out of that report. I could not see that it added anything to the subject. Such changes, if any, that were derived by that later study are not reflected in my exhibits or my reports.

(Counsel for Complainants then asked the Court to take judicial notice that by the 1930 census the population of Charleston was 480, the population of Calhoun was 275 and the population of Rockford was 350.)

In Defendants' Exhibit 108 entitled "Percentages of Channel Distance that are Less than 20 Feet in Depth in the High Dam Pool", none of the 179.8 miles of channel in Gilbertsville reservoir with a depth in excess of 20 feet would have a width of between 50 and 150 feet or between 150 and 300 feet. It would all be in excess of 300 feet wide. We have studied the necessity for dredging below Pickwick, which of course would be dredging in the upper end of the [fol 1455] Gilbertsville pool, and that dredging would extend downstream some three or four miles, and in that dredged cut the channel width would be somewhere around 300 feet. That is not 20 feet deep but that would be the only part of the Gilbertsville pool that would be less than 300 feet wide. It is my testimony that in every one of the pools shown in Defendants' Exhibit 108, the mileage which I indicate as having a depth of 20 feet or more has a width in excess of 300 feet at all points where there is a depth of 20 feet.

Examination by the Court:

It is not my testimony that in Gilbertsville all of the stretch of 184.2 miles has more than 20 feet in depth. My testimony is that 4.4 miles of that stretch is less than 20 feet in depth. As I understand it, the point of the question was whether

any of the channel shown in the exhibit as more than 20 feet in depth, is less than 300 feet in width. If the channel is 20 feet deep I think it is true that throughout the pool it is more than 300 feet in width.

Direct examination continued:

The depths which are shown on Defendants' Exhibit 108 are taken at the so-called normal pool levels. My testimony with respect to the percentage for each pool which in my opinion would be less than 20 feet in depth under the low dam plan was also based on the normal pool of the low dam system. It had nothing to do with the flow conditions at all. There would be slight water development. It was based upon flat pool conditions.

I think that either two or three feet is the standard over-depth in the Ohio River 9 foot project. I understand that [fol 1456] they don't have that over-depth throughout, but they are trying to get it with dredging. I would not say that the over-depths in the Ohio River 9 foot project are not from two to three feet. I believe they are trying to obtain as well as they can the 2 or 3 foot over-depth. I don't know when the last dam completing the Ohio River project was finished. There are two new dams in there, and the one at Gallipolis is not finished now. I think the original Ohio River project was completed in 1929. Possibly it was completed in 1928. House Document 328 on the low dam plan was submitted to Congress in 1930.

I think it is a fact that the 9 foot project on the Illinois River has an over-depth of approximately 3 feet and that that plan was prepared and reported by the Corps of Engineers under standard practice to Congress in 1926. That, of course, was four years before the report of the Corps of Engineers on the low dam plan for the Tennessee River. I believe that the dam which was finished in 1928 on the Ohio River was a wicket dam. It is a fact that the 9 foot project on the Kanawha River has over-depths of 3 feet and that that project was not only designed and recommended and reported to Congress but was actually in a large part completed several years ago.

Defendants' Exhibit 110 entitled, "Comparison of pool fluctuations with high dam and low dam terminals," is not a comparison with high dams and "a low dam project." This time I really meant the low dam project adopted by the

Congress. For the high dam I meant the TVA Unified Plan. There is a relation between the existence of adequate terminal facilities and the development of water commerce. There is also a relation between the existence of substantial, actual or potential water commerce and the construction of adequate water terminals. You can not get traffic without terminals, and you would not build terminals without some [fol. 1457] potentiality of traffic. It is not right at all to say that when you find there are no water terminals, that may be because there is no potential traffic, or at least no one had confidence in it. That could be true, but, on the other hand, it might easily be because the channel was not improved so that there would be any worthwhile commerce.

I believe I have seen the water terminals at Cincinnati, Cairo and Memphis and I would say that they are seriously embarrassed in handling large quantities of commerce by reason of comparatively wide fluctuations of water levels at the water terminals. The one at Cincinnati has a very great vertical lift because of the variations in stage. I believe it does handle substantial commerce. It is a big terminal. As a matter of fact there are wide fluctuations in stage on the Monongahela and upper Ohio Rivers. It is a fact that the largest river commerce in the United States is and has been carried for many years on the Monongahela and upper Ohio Rivers. Their costs of handling are increased by those great fluctuations in stage, but that factor did not prevent terminal facilities from being constructed on those rivers and will not prevent it if other factors are strong enough to overcome that unfavorable factor.

I testified that terminal developments are being considered at the three locations shown on Defendants' Exhibit 110. The TVA is considering terminal locations at Wilson Dam, Decatur and Guntersville. When I said that they were being considered by an undisclosed party I was referring directly to the TVA. There are other plans under way by private parties. As to any private interest that is about to initiate construction of a terminal at either or any of these three places, there have been inquiries from the oil companies in regard to Decatur and Guntersville, but there is no actual construction. I understand their plans are [fol. 1458] under way. The total urban population in the vicinity of Wilson Dam is 25,000 to 30,000 in Florence, Sheffield and Tuscumbia. Such terminals as now exist

are below Wilson Dam. As to whether where those terminals are, there is almost no urban population, there are a few private developments over there on the Florence Canal which is right opposite Florence. There is urban population right near by in Florence and Sheffield. The population at Decatur where the terminal is under consideration is about 15,000 and that is on the river. The population at Guntersville is around 2,500 or 3,000. There are no large industries at Guntersville but there are some pretty substantial ones. There is a spinning mill, a saw-mill, a basket factory and several other small developments. The comparable population figure in the industrial index at Chattanooga is supposed to be 125,000 to 150,000, and the industrial development is quite large. There is a great deal of industry at Chattanooga. It is a very large industrial center. The comparable population figure and industrial index at Knoxville is quite large.

At Florence there would be no great difference in pool fluctuations between the high and low dams. As to whether there would be none, if you consider the flood control element provided by the high dam plan, there would be somewhat less fluctuation with the high dam scheme. The comparable fluctuations between the high dam and the low dam plan at Chattanooga would be the same, but there is no chance of an argument there because of the existing Hales Bar pool. There would be no substantial difference, as the existing Hales Bar pool affects Chattanooga. As to whether there would be no difference at Sheffield, my answer for Florence would be the same for Sheffield. There would be no difference in pool fluctuations between the high and [fol. 1459] low dam plans at Knoxville. Florence, Sheffield, Chattanooga and Knoxville are the most important industrial centers and sources of water traffic now existing on the Tennessee River. In Florence and Sheffield the terminal above Wilson Dam would serve them best, Wilson Dam is in either plan.

A pilot holds his tow against the wind as much as he can when it is exposed to wind action tending to blow it from its course. He holds his rudder over so that the tow is forced against the wind as much as the limitations of the channel will allow. If the wind is blowing against him from his right, he would hold his rudder against the wind so as to keep him from going to the left.

I testified in the Ashwander case that the same type of vessel could be used between Pickwick and the mouth of the river as that used on the Mississippi and Ohio Rivers, but it would be necessary to load that equipment a little lighter. I think that was on the unimproved channel below Pickwick. It is still unimproved.

"Q. Well, if it is not so improved, the result of what is going on now will be to have inadequate navigation at the mouth and inadequate, wholly inadequate, navigation north of Chattanooga? That is a fair statement, isn't it?"

A. Navigation conditions would be poor above Chattanooga and fair between Pickwick and the mouth.

Q. But there would be an interval between the mouth where it would not tie in with the navigation equipment in the Ohio and its tributaries and in the Mississippi Valley System and it would not tie in with the pool level beginning at Pickwick up to a point above Decatur?

A. It would tie in with the equipment. They would have to load a little lighter."

[fol. 1460] The point there is with the river unimproved below Pickwick, the standard equipment now used on the lower Mississippi and Ohio could be used but would have to be loaded a little lighter, because with the river condition below Pickwick in its present unimproved condition, the minimum depth with Norris regulation would be around 7 feet and with Norris and Hiwassee it would be around 7½ feet. I do not believe, with the construction of Gilbertsville reservoir, it would be necessary to increase the structure and strength of river equipment so as to stand the stresses and strains due to wave action. Of course, new equipment is being designed and built all the time and they are building bigger and heavier equipment, but what they now have could certainly be used without trouble.

As to whether I have had any experience in obtaining insurance on vessels engaged in commercial operation, I have discussed the matter with insurance men. I have not actually insured any vessels so operated. I have never operated standard river equipment as a commercial proposition over any stretches of open water of two miles or more in width.

On Defendants' Exhibit 115 entitled "Theoretical Efficiencies of the Tennessee River waterway", as to whether

I calculate that the average current velocity of the Tennessee River under the low dam plan would be two miles per hour throughout the year, that is not the average throughout the year. As to whether I calculated it to be that average throughout the year, 2 miles per hour is the best average figure that I could use for the calculations. For calculations of this kind, you must use an average figure. It is deceptive to a certain extent. I used it.

In computing the comparative times consumed in lockage, I made no allowance for time saved under the low dam plan [fol. 1461] by the use of open river navigation. I have made no allowance for the loss of time at TVA locks by reason of breaking tows to change for a single lockage. The lockage times are calculated on the basis of single lockages. As to whether I believe the commerce on the Tennessee River will be so insignificant that it will be handled in tows so small they can pass through the small TVA locks without breaking tow, there will be nothing so very insignificant about tows of that size. I think tows of that size would be the standard size tow for the river. I assume that commerce on the Tennessee River would be small enough that it could and would be carried on small tows for the first few years at least. This exhibit was not necessarily only intended to show a more favorable condition for a short period of time although it shows a reasonable average condition in the predictable future. What I have shown is I think fair and accurate for the first few years of operation, not indefinitely but for a considerable period of time. I include the time involved in passing through Dam No. 1, Florence Canal, Wilson pool and locks and Hales Bar pool for the low dams and the TVA dams as well, those projects are common to both plans. I include those in my computations. 65 minutes is involved in either plan for passing through Dam No. 1 and 113 minutes for passing through Wilson Dam. I used the same figures for both plans. The figure for Wilson Dam does not include going through the lake, but only the time consumed in passing through the lock. The time consumed in passing through the lake comes in under running time at the rate of $5\frac{1}{2}$ miles per hour, minus the current velocity correction. I do not have that figure separately for both plans, but it is calculated on the basis of $5\frac{1}{2}$ miles per hour, minus one-half mile an hour going upstream through Wilson [fol. 1462] Lake and plus about .2 of a mile coming down. 113 minutes was lockage time alone at Wilson. I do not

have the time separately that it would take to go through Florence Canal, I have calculated that by taking $5\frac{1}{2}$ miles an hour times the distance. For Hales Bar lock I calculated 89 minutes for passing through, and that is the same for both plans. The calculation for Hales Bar pool comes in under running time, not a separate compilation, and that is arrived at the same way I described Wilson Lake.

The basis for my taking credit in downstream trips for only $\frac{1}{4}$ th of the current velocity is just my judgment that you could not take full advantage of the current velocity and it seemed that about 25 per cent would be right. I have never operated a commercial barge line. I have operated and been on boats and have observed the process a great many times.

I testified that a certain type of navigation plan could be constructed on the Tennessee River for about \$144,000,000 and I had 20 locks in all, including the existing Lock and Dam No. 1, and the existing Wilson and Hales Bar dams. So I really had 17 locks and dams in addition to those 3 existing in 1933. I have a table here (offered and received in evidence as Complainants' Exhibit 917) showing the location and lift of the locks for this plan. This exhibit correctly shows the location, lift in feet, pool elevation in feet, and the composition of the dam as I designed it.

In the case of the TVA dams the elevation of the lower lock sill at Pickwick is 342.2 feet and of the upper sill is 398 feet. At Wheeler the lower sill is 491 feet and the upper sill is 534 feet. At Guntersville the lower sill is 538 feet [fol. 1463] and the upper sill is 578 feet. At Chickamauga the lower sill is 618.2 and the upper sill is 663.0 feet.

Examination by the Court:

When I speak of elevation, I am referring to height above sea level rather than the height from the ground at that point. The locks sills are concrete structures that go across the lock chambers at the upper and lower ends and on which the lock gates rest. In other words, the lock gates are steel gates which open and shut like a pair of doors and these doors do not extend to the bottom of the reservoir which would be rough and would not effect a good closure, so there is a concrete sill put in there under each set of gates at the upper and lower ends of the chamber to make the closure.

Cross-examination continued:

I do not have the elevation of the upper and lower lock sills of Gilbertsville. As to whether I can supply that later, the plan is in a state of flux. I do not know just what the status of the design is. I do know where the lock will be but I am not sure as to the sill elevation. The elevation of the upper and lower lock sills for Coulter Shoals is in the same status and so far as I know no elevations are definitely fixed.

I do have something to do with navigation for the TVA. We have some preliminary figures on those. I would not think that anybody else would know better than I do. As to how I compute the navigable depths by drawing down pools in advance of floods without knowing the elevation of the lock sills, we would have some tentative figure on that. [fol. 1464] I can give you as good a figure as we have.

"Q. How do you compute navigable depths, by drawing down pools in advance of floods, without knowing the elevation of the lock sills?

A. Well, we would have some tentative figure on that, that I could give you, as good a figure as we have on it.

Q. That is only used when any of the witnesses have been testifying about pulling down the pools, like Gilbertsville and Watts Bar in advance of a flood, and preserving the navigable channel, they have been dealing with a rubber lock sill in the sense that none of these were fixed and they could slip in any one they needed?

A. I do not know as they could slip one in that was needed, no. They would have to keep one in line with the preliminary plans we have."

I am the navigation expert and I do not know for sure what the elevations for the lock sills will be. I can give a preliminary figure on it if you will treat it as preliminary. None of the other witnesses would know any better than I about it. I could give the elevation of the lock sill at Watts Bar very roughly. I ordinarily place the lock sill at from 12 to 14 feet below the lowest contemplated draw-down. At Watts Bar, as I recall it, the lowest draw-down in anticipation of a flood was down to about elevation 736, in which case the upper lock sill would be about 724 or 722 in elevation. The lower lock sill would be governed by the Chickamauga pool, and as I recall it, the lowest elevation at which

we would allow the Chickamauga pool immediately below Watts Bar lock was 675 and the lock sill would be some 12 feet below that. I don't recall the greatest draw-down elevation at the Coulter Shoals Dam. It would be, I am just estimating, somewhere around 803 and the upper lock sill would be around elevation 790. The elevation of the lower lock sill would be governed by the Watts Bar pool and that was to be drawn-down to 736, and that minus 12 feet would be about elevation 724 for the lower lock sill at Coulter Shoals. The upper lock sill for Gilbertsville would be placed [fol. 1464a] from 12 to 14 feet, or maybe more, below the lowest pool drawdown, whatever that was, but I am not [fol. 1465] sure what the maximum drawdown is at Gilbertsville in anticipation of floods. I can make an estimate of the elevation of the lock sill at Gilbertsville, about elevation 330 for the upper sill and about 290 for the lower sill. At Gilbertsville we have had lots of preliminary studies over the past year or two, I suppose.

Examination by the Court:

There are preliminary plans that have been made for the work at Gilbertsville and explorations for foundations have been carried on very intensively in the field. As I understand it, the actual plans for construction of the dam are not completed and the actual construction has not begun at all.

Cross-examination continued:

I do not know more definitely than I have stated what the lock sill elevations at any one of these three dams not yet under construction will be. As to whether I ever gave any of the witnesses who testified here any definite sill elevations, they understand the preliminary situation. I actually gave them the preliminary lock sill elevations. I think they are right around the ones which I have stated today. There are any number of plans and it is hard to tie the thing down right now.

In the pools like the Wheeler pool we have removed the stumps in lots of places. That is something which the Corps of Engineers in recent years has required every power company to do when it builds a power reservoir on a navigable stream under license from the Federal Power Commission. It may be that the Corps of Engineers has required that

since the Federal Power Commission was founded in 1920. I had in mind Hales Bar pool which was not cleaned of stumps, but that dam was completed before the Water [fol. 1466] Power Act. I don't think that was built under the present Water Power Act. I do not know of any reservoir built on a navigable stream since the Federal Water Power Act was enacted in 1920 where that was not done by a power company. We provided certain harbors of refuge on Wheeler Lake.

Redirect examination:

Defendants' Exhibit 115 represents the relative efficiency of the two plans for an indefinite period, if you assume that the large size locks for which space has been provided are to be installed as soon as the volume of traffic warrants such installation. In the lower ends of all of the high dam pools, there will be substantial distances along the shore line at which there will be minor fluctuations in pool levels. That type of shore line would be well adapted to the use of the terminals.

"Q. Now, do you know anything about whether any oil company has recently made any purchases of land for terminal sites along the Tennessee River?

Mr. R. T. Jackson: I object to that. That is not the best evidence.

Mr. Fitts: I am asking him whether he knows.

Mr. R. T. Jackson: It is hearsay.

Judge Allen: He can answer whether he knows.

Mr. R. T. Jackson: May an exception be noted, please.

Judge Allen: Just answer the question, whether you know.

A. Yes, I do know.

By Mr. Fitts:

Q. What do you know about it?

Mr. R. T. Jackson: The same objection, please.

Judge Allen: Objection overruled. You may have your exception.

Mr. R. T. Jackson: Exception noted, please.

[fol. 1467] A. The oil companies have purchased land in Decatur for terminal purposes and have under way purchase plans in Guntersville, Alabama."

The cost of operation of the terminals at Cincinnati, Cairo and along the Monongahela River is affected by the fluctuation in pool level and the cost of construction is also affected. Both of these items of cost would be reflected in the cost of transportation.

"Q. Mr. Barker, you testified on cross-examination, I believe, that there could be a navigation improvement by a low dam system if it had been started in 1933 at the cost of Wheeler and Norris Dams. Now, did you mean by that a navigation improvement of the same type and standard as that which would be provided by the TVA projects constructed and under construction?

Mr. R. T. Jackson: I object to the question as not proper redirect examination. I asked him whether the low dam plan could not have been completed by this time with that money, and he said it could. He has already attempted to show what he thinks are the advantages and it is not proper to repeat them.

Judge Allen: The objection is sustained to the form of the question.

By Mr. Fitts:

Q. Mr. Barker, I will ask you whether in speaking of a navigation improvement that could be completed at the cost of Norris and Wheeler Dams, you were speaking of an improvement comparable to the type of improvement by the low dams as reported in House Document 328, or the type of improvement comparable to that which will be provided by the construction of the dams included in the TVA plan?

Mr. R. T. Jackson: I object to that as just an evasion of the previous ruling. My question was plain, I asked him if he could have built the low dam plan by this time with that money and he answered 'Yes'. I did not mean, could he have built something.

Mr. Fitts: I don't see the objection. This question certainly is not leading.

Judge Allen: He may answer.

Mr. R. T. Jackson: Exception, please.

[fol. 1468] A. I was referring to a low dam project that would provide navigation facilities such as that contemplated in the low dam scheme of House Document 328. Such facilities would be in no way comparable to the facilities provided by the high dam plan for navigation."

When a certain pool level has been determined, I fix the lock sill elevations for the designers to give the necessary clearance. That is the way that lock sill elevations are determined. The lock sill is put down at a sufficient elevation to give a reasonable clearance in view of all other governing conditions.

The apparent discrepancy between my figure of approximately \$25,000,000 for the amount expended upon the Tennessee River for navigation improvements, excluding Wilson Dam, prior to the creation of the TVA, and the figure appearing in the report of the Chief of Engineers of approximately \$18,000,000 is because I obtained my figure from the District Engineer at Nashville, accepting his interpretation of preliminary reports in 1934. All of those figures taken do not appear in the 1934 reports as they were finally published.

"Q. Your attention was also directed to an apparent discrepancy between your estimate of the cost of operation and maintenance of the high dam system as proposed in the TVA plan and the estimate in the 1936 appropriations hearings. I would like to ask you how you made up your estimate and what items you included in it.

A. In the high dam plan my figures covered just the operation and maintenance on the locks plus the maintenance dredging below the locks.

I made my own individual estimates on that.

Mr. Fitts: May it please the Court, I would like to state that with respect to the exhibits showing the amount expended on previous projects—I don't have the number right now—on the Tennessee River, in order to be completely fair, I would like the opportunity of changing the figure on that exhibit to the \$18,000,000 figure as reported [fol. 1469] in the report of the Chief of Engineers, because I think there is confusion as to that \$25,000,000 figure.

Judge Allen: Is there any objection?

Mr. R. T. Jackson: I am sorry; all I heard was that they wanted to correct the figure. There is no objection to that.

Mr. Fitts: We want to change it from the \$25,000,000 to the \$18,000,000.

Mr. R. T. Jackson: There is no objection, as long as the record shows that the witness made the mistake in the first instance.

Mr. Fitts: He has not said he made the mistake.

Judge Allen: The change may be made."

Recross-examination:

In my estimates of the maintenance and operation, I did not include any share of the maintenance or operation of the dams and reservoirs. I omitted that entirely from the figures I have given here.

The fluctuations at Cincinnati increased the cost of terminal operations. I never heard of any report of the Corps of Engineers recommending to Congress that it spend \$500,000,000 to eliminate these minor fluctuations in terminal costs at Cincinnati.

(The witness was excused.)

[fol. 1470] "Mr. R. T. Jackson: At this time I want to ask Mr. Fitts, at page 4146 (of the stenographic record), the Court requested the Authority to produce a copy of the Debler report from their files. That has not been done yet.

Mr. Fitts: I would like to inquire of the Court, we have the copy available, but I would like to state our position briefly. We would like to submit a copy of that report to the Court together with a memorandum brief which we have written on the admissibility in evidence of that report or any part of it, and ask the Court to consider its entire contents, together with the authorities on the rules of evidence that we have in our memorandum brief.

Judge Allen: This is the report made by a single engineer, is it?

Mr. Fitts: An engineer of the Bureau of Reclamation, that is correct. And if the Court is then of opinion that the report should be produced to the complainants and so orders, we will do so. We do not desire to turn the report over to the complainants except after the Court has considered the question of its relevancy and admissibility, and expressed its view thereon.

Mr. R. T. Jackson: I would also like to say further that we ask to use this in connection with cross-examination,

which is a different question entirely to that as to pure admissibility.

Judge Allen: The Court will bear that in mind.

Mr. Fitts: The first question is whether the complainants have the right to demand the production of a document which in our opinion is clearly irrelevant and immaterial in this case.

Judge Allen: The Court will examine your document and brief.

Mr. Fitts: I will get that in a few minutes. I would like to proceed with the examination of the witness.

Judge Allen: The Court will want to examine it very thoroughly sometime after recess this afternoon.

Mr. R. T. Jackson: Of course, in that time we will not be able to write a very good brief."

[fol. 1471] JAMES S. BRODIE was called as a witness on behalf of the Defendants and, having been first duly sworn, was examined and testified as follows:

Direct examination:

I reside in New Orleans, La., and my present position is Superintendent of Maintenance of the Federal Barge Lines, and in addition to that I act as chief engineer of the lines. I have been connected with boats all through my other experiences. I went to school in St. Paul, Minn., and then went to the University of Minnesota. Then I went with a traction engine company and was in the tractor business for a number of years. I then started a barge line on the Mississippi River and operated between Minneapolis and St. Louis. About 1920 I went with the Federal Barge Lines and have been with them ever since. I operated that barge line of my own about five years.

The Federal Barge Lines is the name of the operating part of the Inland Waterways Corporation, which is owned by the Federal Government, to operate inland waterway service to cover water transportation on inland rivers. The Federal Barge Lines operate a railroad from Ensley, near Birmingham, to the port of Birmingham, and they operate on the River from the port of Birmingham to Mobile, and from Mobile to New Orleans. From New Orleans they operate up the Mississippi River to St. Louis, up the Missouri

River to Kansas City, up the Illinois River to Chicago, and up the Mississippi River to Minneapolis.

The Federal Barge Line uses nearly all types of equipment, except the very small types, and we even have some which are called small gas boats, but we operate about 300 barges and 26 or 27 towboats of various sizes and descriptions. Nearly every type of navigation condition that might [fol. 1472] be put into the category of inland waterways is encountered by our operations. All these rivers which we pass over have wide spaces and narrow spaces, swift current and slack water, so we cover almost every kind of inland waterway condition. We operate both in open channel and in improved slack water, through locks and on long stretches with no locks.

As Chief Engineer, which was my title before the reorganization took place about two years ago, I had to deal with everybody from the time I started with the line. I was so intimately connected with the operations that when an emergency existed, they moved me to different jobs. One time they made me manager of the Warrior Division and another time they made me operating manager of the Upper Mississippi Division. In that way, with my experience with the barge line, I have come in contact with the requirements of shipping in connection with shippers and the operation of boats.

Probably the first requirement in furnishing transportation service on the inland waterways of the kind which the Federal Barge Line offers, which is common carrier service, is dependability. When a shipper knows that he can move his freight at a certain time, he is willing to ship. If he is doubtful about that, he is not willing to ship and we cannot solicit the freight.

The channel is the only question which affects the dependability of service that has ever been brought up with the Federal Barge Line, which is soundly financed. Finance is one of the troubles which is generally encountered, but with finances favorable, channel condition is the controlling factor. I would say the requirement for a good channel is [fol. 1473] a minimum amount of interference with a good trip. When a boat starts out to make a trip, if they encounter trouble, we refer to it as "bad channel". Usually sandbars and swift waters are the main things to hold up a trip.

In a manner I am familiar with the projects of the TVA,

so far as they relate to the improvement of navigation on the Tennessee River, through the description that the TVA men have given me of their projects and the trip that they took me on down through Wheeler Lake. I am generally familiar with the type of channel that is created by the kind of movable wicket dam that is referred to in House Document 328. In general, in my opinion moving freight by inland waters, the amount of water channel available is the measure of the value of the channel; that is, a deep, long slackwater pool is much more easy to traverse, much more dependable, than any other kind of inland waters. I am not very much familiar with the Ohio service, I have been on the Ohio, but we do not operate there. We have a good many barges interchanged between our line and the Ohio River companies and I have been up the Ohio. Those dams with wicket gates are let down in high water and there is a swift current usually over those dams as a rule, over the whole river at the time they have to let those dams down. Swift current is a bad thing and runs up the cost of operation materially.

By Mr. Fitts:

Q. In your opinion, Mr. Brodie, will the same type of equipment, which is now operating on the Mississippi and Ohio Rivers generally, be able to operate upon the Tennessee River after the completion of the high dam plan as it is being carried out by the Tennessee Valley Authority, without change in design or change in loading?

A. In general, all the equipment that the Federal Barge Line uses is adaptable to the new TVA river, the Tennessee River.

Mr. R. T. Jackson: I object and move to strike out that answer.

[fol. 1474] Mr. Fitts: I think it is certainly a partial answer. I will ask him to go ahead.

Mr. R. T. Jackson: That calls for a general answer and not for particularizing.

Judge Allen: The objection is overruled. He may answer.

Mr. R. T. Jackson: Exception noted, please.

A. The Federal Barge Line tows other equipment frequently, equipment owned by other companies, and nearly all of that equipment that comes to New Orleans is adaptable to the Tennessee River when improved. There are

some barges that operate up around the Pittsburgh district on the Ohio River that would have to be handled with a little more care on the big pools of the Tennessee River than they would on the Ohio. Those barges, however, are all busy and I don't see how they can get on the Tennessee River, because they are all building new barges, and the new barges that they are building are being fixed so that they would not be interfered with at all; that is, you could operate the new barges as well on the Tennessee River as you could on the Mississippi."

I am not sure whether the Monongahela type coal barge is being duplicated now or not. They build those barges without any coamings.

Examination by the Court:

A coaming is a sort of a raised fence around the top of an open barge. An open barge frequently has a deck of two or three feet from the side in, and a coaming is a kind of fence upon that. A great many of the barges operated on the Ohio River already have those coamings, and they use them for sand and gravel, and it has a tendency to increase the freeboard and put the vessel higher up above the water and so the waves cannot wash in.

[fol. 1475] Direct examination continued:

I have not seen those barges used for much other than coal, although once in a while in an emergency they do load them with steel and sometimes we have had experiences in handling those barges with such loads in them when they have come onto the Mississippi River.

Assuming that under the high dam system as being developed by TVA there will be only 7 lockages over the entire length of the river, as compared with 32 lockages as set forth in the low dam plan in House Document 328, in my opinion, the number of locks and dams that have to be passed through is a very material difference to any navigator. I have in my own experience a good deal along that line. Wherever we have to go through a series of locks and dams, it means a serious delay and the number of those that can be eliminated is a material advantage to a navigator. The time it takes to make a lockage is not measured correctly by the time it takes to go through the lifts at all, because a tow

stopping anywhere takes time. A heavy tow with perhaps 10,000 tons of freight in it, which may mean 15,000 or 20,000 tons dead weight load, is difficult to stop, it takes time, it has to be maneuvered, and the slowing down of a tow like that takes time. Starting it up again also takes time. Getting it into a lock means you have to go so slow that when the barge hits the side of a lock guiding itself in, it is not going fast enough to dent it. Very much speed of any kind will dent a barge if it is heavily loaded, hitting the concrete wall or a cushion, as some of the locks have piling.

[fol. 1476] "Q. Assuming that under the high dam plan as being developed by the Tennessee Valley Authority, there will be a minimum actual depth throughout the length of the river of eleven feet, and a depth in excess of 20 feet throughout the major portions of all of the pools, whereas under the low dam plan as reported in House Document 328 there would be the large portions of the pools of a depth not exceeding nine feet, in your opinion is this difference in depth significant to the practical navigator?"

Mr. R. T. Jackson: I object to that question because the statement that under the low dam plan there would be long stretches not exceeding nine feet is not supported by any credible evidence.

Mr. Fitts: It is supported by the testimony of the witness Barker, and at page 1972 (of the stenographic record) the testimony of the witness Putnam.

Mr. R. T. Jackson: I press my objection that it is not supported by other testimony.

Judge Allen: Objection overruled.

Mr. R. T. Jackson: Exception noted, please.

A. The matter of depth is important to a navigator, because when he gets in shallow water—for instance, a tow drawing eight feet and sounding nine feet, the captain of the vessel must go slow, he may hit something, and when he hits something, he is in trouble. So, the tow will go slow when it gets in shallow water. Then it is harder to drive a boat over a shallow stretch of river than it is over a deep stretch. It takes more power to make the same speed."

Assuming under the high dam plan as being developed by TVA, the fluctuations in pool levels will be substantially

reduced along the river as compared with the fluctuations which would exist in the pools under the low dam plan as reported in House Document 328, generally the variation in the pool level would make no difference to a navigator. It makes a great deal of difference to the development of navigation. It makes some difference as to the matter of the boat moving. In the low dam plan, as I understand it in this House Document 328, a shallow stretch of river at the head of each pool is left, which is a relatively longer shallow stretch of the river and that part of the river has [fol. 1477] currents, whereas the high dam scheme of the TVA has no such thing, it is all pool up to the next dam. So far as the development of river transportation is concerned, the variation in level of the pool has a great deal to do with the terminal development where there is a high variation in water stage encountered, as terminals have to be much more expensive and elaborate to handle the traffic, and it becomes so expensive at a good many places that they have not put up terminals at all that were otherwise desirable because of the excessive variation in stage.

Assuming that under the high dam plan as being developed by TVA current velocities in the pools will be substantially reduced in comparison with the velocities that would exist under the low dam plan as reported in House Document 328, in my opinion that would be a significant fact. Current is a discouraging factor to the river operator. It takes more power to take care of the peak load requirements when an upstream movement is to be accomplished, thus requiring more capital investment in equipment. We have noticed in considerable experience that any current in the river has a tendency to create sandbars, and regardless of any engineering experience and previous calculations, those sandbars get ahead of them. Coming downstream in the condition where you have a swift current moving a heavy tow, it encourages difficulties about grounding because of the difficulty in handling a tow when the current is coming on.

If the movable wickets in low dams were down and the navigable passages in the dams were in use 67 per cent of the time, it would indicate to me that there would be a current during that 67 per cent of the time that a towboat [fol. 1478] would have to stem when moving a tow upstream, otherwise there would be a small saving in lockage

time due to the possibility of passing the tows over the dams, but the difficulty of bucking a current I should think would more than overcome the saving you get in lockage time. As to whether in my opinion additional equipment would be needed for service on the type of channel created by the low dam plan or equipment using more power than would be needed on the type of channel that will be created by the high dam plan, that matter of current comes up again. When you have a current you have to have enough power to push these tows against this current. Every tow that comes down the river has to go up and we need enough power to push the tow against the current, which is more power than is needed to push it in slack water.

Fairly good terminal facilities are one of the vital factors in any transportation system. On the river it is just the same. The overall cost of handling freight, that is common carrier type of freight, is 50 per cent absorption in terminal handling cost, so the efficiency of a terminal is the vital factor. Fluctuations in water level cause difficulty and increase the cost of construction and operation of river terminals. Assuming that the construction of the high dams would result in a substantial reduction of fluctuations of water levels over those that would obtain under the low dam plan, it would rather encourage more efficient terminals on the river than would be with a wide variation of river level. In my opinion this would probably have an effect upon the actual development of river traffic. The cost of river traffic and the dependability of service is what is going to attract the freight on the river and anything [fol. 1479] that can be done to minimize the cost will encourage river traffic.

As to whether practical navigation men prefer wide pools created by the high dam plan as carried out by TVA or the narrow pools of the low dam system, I prefer the long, wide pools. In navigating the Mississippi River below Cairo, I encounter difficulties due to low water.

"Q. Assuming that that stage at Cairo could be increased by as much as one foot in the low water season by releases of water from the Tennessee, would that in your opinion be of substantial assistance to navigation on the Mississippi?

Mr. R. T. Jackson: I object to the question, first there is no basis in the record for the hypothesis; second, under the

statute the Tennessee Valley Authority has nothing to do with the low water in the Mississippi.

Mr. Fitts: May it please the Court, if it will save time I will withdraw the question and frame this one.

Q. Mr. Brodie, assume the stage at Cairo could be substantially increased in the low water season by releases of water from the Tennessee, would that in your opinion be of substantial assistance to navigation on the Mississippi?

Mr. R. T. Jackson: I object to that for the further reason 'substantial' means nothing.

Judge Allen: Objection overruled. 'Substantial' means something.

Mr. R. T. Jackson: If your Honor please does 'substantial' mean foot, or mean two feet?

Judge Allen: You have objected to a foot. 'Substantial' has been accepted. There is testimony in the record, the three members of the Court remember the testimony is in the record supporting this question. Objection overruled. You may have your exception.

Judge Gore: The question has been more or less observed from the first of the trial, because there has been controversy between counsel as to what it meant on that day.

Mr. R. T. Jackson: That is right, but if any disinterested engineer would be called to the stand and asked what 'substantial' means, no one could answer as to the change in depth on the Mississippi River. And if anyone undertook [fol. 1480] to give an answer, no two being in the same room would agree.

Judge Allen: The objection is overruled. The word 'substantial' means something, it is different from insignificant.

Mr. R. T. Jackson: May we have our exception?

Judge Allen: You may have your exception. You may answer.

Mr. Fitts: Do you understand the question or do you want it read back to you?

The Witness: I think so. The additional water coming from the Tennessee into the Mississippi raises the stage of the Mississippi during low water, and will substantially aid navigation. Is that the proper answer?

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The Witness: When I asked was that the right answer, I referred to the right usage of the words, particularly to the word 'substantial.' I was not sure as to just how the question was stated, and I wanted to get the kind of answer that would fit the question, so I asked whether that was the right answer."

My experience does not coincide with the view that port-to-port traffic is the first to develop on an improved waterway and that no great volume of joint rail and waterway haul is to be anticipated in the early years, and will not develop until later. Our experience in the common carrier service is entirely opposite. We anticipate and get more joint transportation at the start of any service than we do port-to-port tonnage. We make rates as common carriers with railroads as soon as a channel is open for navigation and our barge line is put to work on it, and usually about 50 per cent or more of the traffic is joint traffic. As a matter of fact about 70 per cent of it is generally joint rail and water traffic. It is very difficult to get tonnage moving on any waterway and the ease with which the navigator can handle the freight and the dependability which he can offer to shippers are the big factors in getting cheap [fol. 1480a] transportation service to offer. If transportation is not offered cheaply and dependably, it will not come. The high locks and high dams in my opinion certainly will [fol. 1481] make cheaper and more dependable operations than the series of low locks and dams, and therefore will better encourage transportation on the river than otherwise.

By Mr. Fitts:

"Q. Mr. Brodie, assuming that under the high dam system as being developed by the Tennessee Valley Authority there will be only seven lockages over the entire length of the river as compared with 32 lockages in the low dam plan as set forth in House Document 328; further assuming that under the high dam plan there will be a minimum actual depth throughout the length of the river of eleven feet, and a depth in excess of 20 feet throughout the major portions of the pools, whereas under the low dam plan as reported in House Document 328 there would be large portions of the pools of a depth not exceeding nine feet;

further assuming that under the high dam plan as being developed by the Tennessee Valley Authority the fluctuations in pool levels will be substantially reduced as compared with the fluctuations that would exist in the pools under the low dam plan as reported in House Document 328; further assuming that under the high dam plan being developed by the Tennessee Valley Authority current velocities in the pools will be substantially reduced in comparison with the velocities that would exist under the low dam plan as reported in House Document 328; I will ask you whether or not in your opinion the high dam system will provide navigation facilities for the man who has to navigate substantially superior to those that would be provided by the system of low dams reported in House Document 328.

Mr. R. T. Jackson: I object to that question because, among other things, it assumes that in House Document 328 there is to be a minimum of nine feet over a large part of the waterway, which is not in accord with the fact or the practice of the Corps of Engineers.

Mr. Fitts: It is not in accord with the practice?

Judge Allen: On that, Mr. Jackson, point to the place where it shows a depth of more than nine feet.

Mr. R. T. Jackson: It appears as a question of practice, if your Honor please. When they have a nine foot channel they have over-depths of two to three feet, and Mr. Barker undertook to say on the basis of a very limited experience that that was not the practice of the Corps of Engineers, at least at the time of House Document 328, and on cross examination I brought out by his own admission that that had been the practice on the nine foot projects on the Ohio, the Illinois, and the Kanawha River-, among others, which are identically the same kind of nine foot recommendations as in House Document 328. Mr. Barker is simply mistaken in his assumption.

Mr. Fitts: I don't think you can ignore the testimony of any witness herein—I think if the fact is testified to by—

Mr. R. T. Jackson: If you please—

[fol. 1482] Mr. Fitts: Wait just a minute. I think if a fact is testified to by any witness you can frame a hypothetical assumption based upon it. Furthermore, this witness with such limited experience has had eight years in-

tensive work on this river, and eleven years experience with the Army Engineers, is probably better qualified than any man who has appeared in this case to testify about the Tennessee River.

Judge Allen: The objection is overruled.

Mr. R. T. Jackson: May I add the statement also that Colonel Watkins, who drafted 328, testified, as I recall, that it called for overdraft.

Mr. Fitts: I beg your pardon, he did not.

Judge Allen: All that goes to the weight.

Mr. Fitts: There is no such testimony in the record.

Mr. R. T. Jackson: I don't want to argue, I want to make my grounds for objection complete so as to be fair to the Court.

Judge Allen: Objection overruled. You may have your exception.

Mr. R. T. Jackson: Exception noted.

A. It is my opinion that the TVA Plan with seven locks and dams is superior—will create a superior navigable channel to the channel which would be created by the plan of the Engineers with 32 locks and dams."

Cross-examination:

The Mississippi Warrior Barge Service has always been conducted by the Inland Waterways Corporation, or a predecessor. The Inland Waterways Corporation has been a federal corporation, owned and operated by the Federal Government. My entire experience since 1920 has not been with that line. I went with the barge line in 1927. It may have been 1926, that I went with the Inland Waterways Corporation, but previous to that I stated that I was operating a corporation of which I was president and manager, a barge line on the upper Mississippi between Minneapolis and St. Louis, as a private institution. I have been with the Federal Barge Line for the last ten years. That is a federally owned and operated enterprise. I would not say it was subsidized by the Federal Government.

[fol. 1483] "Q. Mr. Brodie, do you not know it to be a fact that when the Chief of Engineers made an appraisal of the property of the Inland Waterways Corporation somewhere around 1928 or 1929 or 1930, perhaps a year or two later he reported that whereas some \$30,000,000 worth of

property had been turned over to the Inland Waterways Corporation by the Federal Government the appraisal value of its assets was in the vicinity of \$7,000,000?

Mr. Fitts: We object to the question. The value of the property of the Inland Waterways Corporation is clearly—

Mr. R. T. Jackson: The Interstate Commerce Commission, I mean.

Judge Allen: The objection is sustained.

Mr. R. T. Jackson: If your Honor please, may I state the purposes of the question?

Judge Allen: Is not the purpose evident from the question? After all, the Court can see the point as well as the question. Mr. Jackson, we are concerned about having such long statements of reasons in this record which goes on and on and on, with you and us facing a date line. We are concerned about that.

Mr. R. T. Jackson: I am concerned about it too, but I still want to cross examine the witness.

Mr. R. T. Jackson: May we have an exception noted, please?

Judge Allen: You may have your exception."

I don't think I said that the effect of lowering wickets on wicket dams is to increase the current. I don't think that is right. As to whether I said that the effect of lowering the wickets was to increase the current, I did not mean it exactly that way if I did say it. I meant when the wickets were lowered, it meant that the current was increased because the volume of water which was there was sufficient to allow them to lower the wickets. As to whether it is better to have open river navigation than locks and dams where the nature of the stream permits it, the nature of most [fol. 1434] streams would not permit such a statement. The slack water pools are the best ones to navigate in. If we could leave out the locks and dams entirely and have slack water all the way, that would be the ideal set-up. As to whether I would recommend the improvement of a river by locks and dams when the slope and character of the river is such that locks and dams are not otherwise necessary, when you qualify it that way and they are not otherwise necessary, I would recommend leaving it alone. If it is all right, let it alone. I think locks and dams are built in

rivers because the slope is so great that it is not possible to provide the desired channel by open river navigation.

Where you can provide the desired channel without locks and dams, it is preferable to have open river navigation, provided there is not too much current. I don't think I can give a definite answer, yes, or no, on that, because I can look at various rivers that have been improved for one reason or another, and the question is hardly one that I could make a recommendation on. As to whether, even though it were practicable to provide the desired channel of a given depth without locks and dams, in many instances I might recommend the construction of locks and dams in a river, the word-, "desired channel" is baffling to me. When explained as a channel of a given depth, it is baffling to me anyway. I don't know what would be a desired channel. For instance, on the Illinois River, where we have a very slow river, relatively, they put in some small locks and dams, and later decided that the locks and dams did not reach far enough and they put in some bigger ones. Naturally, that is a slow river, relatively, compared with our other rivers. However, I think that the new locks and dams on the Illinois are an improvement over the old. Assuming that it is practicable to provide a channel of nine feet without locks and dams, as to whether I would recommend nevertheless the construction of locks and dams to [fol. 1485] attain the channel of nine feet depth, I would not make a recommendation without a study of any river.

I have operated on the upper Mississippi River and was operating manager of the Mississippi-Warrior Barge Line of the Upper Mississippi Division for a number of years. The Inland Waterways Corporation operates on that section of the river.

"Q. How much have been the average earnings of the Federal Barge Line on the upper Mississippi Division for the past five years?

Mr. Fitts: We object to the question, may it please the Court.

Judge Allen: Objection sustained.

Mr. R. T. Jackson: If your Honor please, this witness is undertaking to claim that it is better navigation with locks and dams than it is with an open river, and he is bas-

ing his experience upon the Federal Barge Line, and I think we are entitled to test the soundness of his conclusions.

Mr. Fitts: I don't think the statement is correct. The witness did not testify to that. He testified that the open rivers assumed certain velocities.

Judge Allen: The Court does not care to go into the ramifications of receipts and expenditures, and so forth. If you want to ask this witness whether the operation was profitable, the Court will allow the answer.

By Mr. R. T. Jackson:

Q. Were there any net earnings, average net earnings, from the Federal Barge Line operations on the upper Mississippi division during the last five years?

A. Up to date the upper Mississippi River project has not been completed and the Federal Barge Line is charged with the duty of operating up there to encourage and develop transportation. My own line up there made money before they put in locks and dams—made a little money. The operation of the Federal Barge Line has, I believe, shown a profit during some years, but the average of all of these years of operation has not shown any profit on the upper Mississippi due to the fact that the channel is not there.

Mr. R. T. Jackson: I move to strike out the volunteered statement about his own operations, in regard to which I did not ask.

[fol. 1486] Mr. Fitts: It seems to me it is a proper part of the answer. He told exactly what he was trying to prove by the question.

Judge Allen: It may stand.

Mr. R. T. Jackson: Exception noted."

The operations of the Inland Waterways Corporation on the Warrior River, as far as I know, segregated from the rest of the accounts, have not been profitable. I think the operations of the Inland Waterways Corporation on the Illinois River Division have been very profitable, but I do not believe our accounts show discrimination between the profits on the Illinois and those which are shown by operation on the Mississippi. I do not think it is a fact that the accounts for the Illinois River Division show that the Inland Waterways Corporation has lost on its operations

there. I think it is the opposite. I think the operations of the Inland Waterways Corporation on the lower Mississippi have been profitable. There were no locks and dams on the lower Mississippi. As to whether it is a fact that the only divisions of the operations of the Inland Waterways Corporation which have shown any profit are in open river navigation on the lower Mississippi, I think the Upper Mississippi Division has shown a profit during the time when the channel was in good condition. I think the Illinois has been showing a profit right along and undoubtedly the lower Mississippi River has a good record to show for a profit during the whole operation. As to whether the Upper Mississippi at the time of which I spoke had no locks and dams, it always had locks and dams during that period at Keokuk, Moline, LeClaire and Minneapolis. I don't know how many miles of the upper Mississippi were canalized at that time. The Keokuk Lake probably made a pool which you would call canalized by the river for 40 miles. The Moline pool was I think 18 miles, the LeClaire [fol. 1487] pool 6 miles and the Minneapolis pool 4 miles. As to whether the rest was open river, that was back in 1920. Since that time more locks and dams have been put in. A great many of them are completed.

Examination by the Court:

The project there is for 26 locks and I think about two thirds of them are completed.

Cross-examination continued:

The new locks that are being put in are mostly low lifts, that is, something under 20 feet. I think they average a little more than 10 or 15 feet, I don't know.

The service of the Federal Barge Line is as a common carrier. The vast majority of commerce on inland waterways is not carried by common carrier but by private carriers. In our experience we generally establish joint rail-water rates. It is not a fact that the Federal Barge Lines by statute have been given special rights with reference to the setting up of joint rail-water rates. Special rights have not been given to the Federal Barge Lines any more than they have to any other corporation that was a common carrier.

"Q. Is it not a fact that the Federal Barge Line has by virtue of Federal statute and the rulings of the Interstate Commerce Commission been given the right to set up joint rail-water rates or compel the railroads to join in such rates with 10 and 20 per cent differentials in favor of the Federal Barge Line?

Mr. Fitts: We object to the question as calling for the witness' legal interpretation of a statute.

Judge Allen: The objection is sustained upon the ground that it has nothing to do with the case.

Mr. R. T. Jackson: The only point—
[fol. 1488] Judge Allen: The objection is sustained. You may have your exception.

Mr. R. T. Jackson: Note our exception, please."

The relation between the rates of the water carrier and any joint water-rail rates and the alternative railroad rates has something to do with the development of water transportation, all rates have to do with water transportation, the same as they have any other transportation. Low rates attract freight while high rates repel it. We do operate under joint rail-water rates, some of our rates are joint rail-water rates.

"Q. And you also, in fixing your rates, enjoy an exemption from taxes and have franking privileges and the like, do you not?

Mr. Fitts: We object to the question, may it please the Court, immaterial and irrelevant.

Judge Allen: The objection is sustained. We are not considering the constitutionality of this statute, of the statute under which the Federal Barge Line operates, nor the constitutionality of the operation. Really, Mr. Jackson, you cannot seriously claim that this sort of thing will decide this controversy or have any material bearing on it?

Mr. R. T. Jackson: May we have our exception? In view of the Court's question as to what I might seriously contend, I want to say that I think the question of whether or not a witness basing his testimony upon the experience of a subsidized Federal corporation with special rates and things of that character is anything by which one may determine what would happen to ordinary commercial opera-

tions on another river, is entirely pertinent and proper cross examination.

Judge Allen: The objection is sustained for the grounds stated and for other grounds not stated and you may have your exception.

Mr. R. T. Jackson: All right.

Judge Allen: I want to call your attention again to the fact that the Court is endeavoring to conclude this case. Findings of fact will be asked for at the conclusion of testimony. We will proceed with the argument immediately, and it will depend upon the time when the testimony is concluded, how much time counsel have in order to take care of those very important matters."

[fol. 1489] The Federal Barge Line operations are not largely conducted in a special type of barge adapted to handling package freight and other cargo requiring the use of covered barges. The Federal Barge Line has open barges and covered barges for package freight and bulk freight, all of them in use. I do not know what percentage of the Federal Barge Line traffic is handled in open top barges, I would say offhand probably 40 or 50 per cent.

As to what detailed knowledge I have of industrial conditions which might affect water traffic on the Tennessee River, I don't know what you mean by detailed knowledge of industrial conditions. In general, I would say that the Tennessee Valley has a potential freight capacity because it is a rich valley. We already handle freight from the Tennessee Valley in the Federal Barge Line and we have some knowledge directly of what might be available up here in a relatively small way, because it is all joint traffic that we handle. I cannot tell what percentage of the traffic on the Mississippi River system is handled by the Federal Barge Line and what percent by the carriers. It would be a relatively small percentage that was handled by the Federal Barge Line.

The disadvantage of going through locks is measured by the total time lost, whatever that may be. As to whether I would recommend an expenditure for the elimination of all or part of lockage on a stream, of an order such that the annual fixed charges would greatly exceed the value of the time lost to transportation through the river, I do not see how anyone can make an estimate of the value of the time lost, when one considers that it may be an effort on the part of the

people putting the money into this thing, that they want to create something that does not now exist, that is, more [fol. 1490] river transportation. I cannot see where there is any measure of that in dollars, and from that standpoint, I do not see how any estimate or recommendation, especially by me, could even be considered. As to whether I would still recommend the expenditure of that money for that purpose, assuming that the elimination of time lost by lockage of a certain number of locks would involve an expenditure such that the annual fixed charges would many times exceed the value of time saved to existing or potential commerce on the river, if the potential tonnage is estimated that might be handled at any time in the future and that is so small that it would not justify in money the expenditure of the capital and maintenance of locks and dams, I would think it would be wrong to put in such locks and dams. However, the question in my mind is who can estimate what the potential tonnage is, so I do not think there is any measure of that which is available to me anyway.

As to whether expensive terminals were built on the recommendation of the Mississippi Barge Line at Davenport and Moline, the Federal Barge Line has no terminals at Davenport and Moline. The cities built them, not with the recommendation of the Federal Barge Line. As to whether they have been practically unused, only one terminal that the Federal Barge Line has had anything to do with at Davenport is a private terminal of an elevator company which we did make some recommendations about and which is in use. It is not true that the municipalities of Davenport and Moline built large expensive terminals when we instituted service on the upper Mississippi River and they are practically unused. They did not build any terminals at all for us. There are no terminals there built by the cities. There is a small terminal at Davenport which was [fol. 1491] used by the old packet boats and I think it has been used recently by some excursion boat. It never was used very much, but it was there long before the Federal Barge Line started business up there. It was built by the city.

We operate on the Warrior, Mississippi and the Illinois Rivers and up the Missouri River to Kansas City and infrequently to Leavenworth to get grain. We operate two miles on the Ohio River from Cairo to Birds Point. Our terminal is two miles up the Ohio River from the junction

with the Mississippi. That is open river navigation. We do not operate on the Ohio up through the wicket dams towards Pittsburgh. It is a fact that there is much more commerce on the Ohio River than on the upper Mississippi. I am familiar with the Monongahela River to some extent. I spoke relatively when I said that one of the things that was necessary in connection with low water flow was a large pool of water in order to make possible good navigation. The Monongahela River has the largest inland waterway traffic of any river in the United States and has been used as the criterion for river advocates for so long, and the only reason for its being used as extensively as it is, is that the City of Pittsburgh and surrounding districts consume the coal, and the coal is up the Monongahela River, and they have what might be called a shuttle service to move that commodity from one fixed place to the other fixed place. They move this shuttle back and forth and this tonnage is built up materially above all other transportation, but it has no connection with what might be expected on other rivers, the tonnage is not the same extent. I believe that statistics show it to be and to have been the largest tonnage on any river for many years. That is because there happens to be commerce existing and moved on the river between Pittsburgh and the coal mines. I do not know it is a fact that the low water flow of the Monongahela is only 160 second feet.

(The witness was excused.)

[fol. 1493] J. H. ALLDREDGE was called as a witness on behalf of the defendants and, having been first duly sworn, was examined and testified as follows:

Direct examination:

I am 50 years of age, reside in Knoxville, Tennessee, and am a transportation economist, which in the business world is frequently referred to as traffic management. After finishing school at the Central Alabama Agricultural School in 1910, and teaching for about a year in the public schools of Alabama, and continuing my studies under private instructors, I formed a connection in 1910 with a canning company in Montgomery, Alabama, and developed its traf-

fic department serving as its traffic manager for about 9 years. Since 1910 I have been engaged exclusively in some kind of transportation work and in the study of transportation problems, mostly of an economic nature. During my service with the canning company in Montgomery, Alabama, I also acted as secretary to the manager of the Montgomery Freight Bureau, which was a part of the Chamber of Commerce. During that time I also acted as traffic adviser to some of the small boat lines operating on the Alabama River. After leaving the service of the canning company, I became secretary and traffic manager of the Dothan, Alabama, Chamber of Commerce. I served in that capacity about three years and then became general freight and passenger agent of the Atlantic & St. Andrews Bay Railway Company, in which capacity I served about a year. Then I accepted a position with the Alabama Public Service Commission at Montgomery, first as examiner and chief rate [fol. 1494] expert and then as director of its transportation bureau, which was in immediate charge of regulation of railroads and boat lines and finally the motor vehicles operating in the state. I held that position for about 12 years.

While I was with the Alabama Public Service Commission, I acted as technical economic adviser to the committee of state regulating commissions which assisted the Interstate Commerce Commission in the general investigation of the freight rate structure of the South, and between the South and the North. I also prepared and presented testimony of a technical and economic nature for the cotton textile interests and the marble interests of the South in the general investigation of their rate structures before the Interstate Commerce Commission. I did that simply as a loan from the Alabama Public Service Commission.

I am the author of "Rate Making for Common Carriers," published in 1929, and was editor and associate publisher of the fourth edition of "Watkins on Shippers and Carriers," published in 1930. I wrote a monograph entitled "Competition as a Factor in Making Freight Rates," printed in 1930, and I contributed an article on transportation economies in the January, 1934, volume of banking and transportation problems. I was principal author of the "Inter-territorial Freight Rate Problem of the United States," published as House Document 264, 75th Congress, First Session, and one of the principal authors of the "His-

tory of Navigation on the Tennessee River System," published as House Document 254, 75th Congress, First Session.

[fol. 1495] I am principal transportation economist and head of the transportation economics division of the TVA. My principal duties are to analyze and study the transportation conditions of the Tennessee Valley, particularly as they relate to navigation on the Tennessee River and the feasibility of coordinating water transportation service on the Tennessee River. I also furnish transportation information and advice to other divisions and departments of the TVA. I have made an intensive study of the movement of commerce in relation to navigation improvements on the Tennessee River since going with the TVA on September 1, 1934. I could not give specific references to surveys and reports which I have studied in connection with the economic value of navigation improvement on the Tennessee River. I have studied a great many of them and particularly House Document 328.

Since the coming of steamboats, the traffic on the Tennessee River in the past has been predominantly local in character and that is particularly true of recent years. In the days of the flat boats and keel boats, the produce of the Tennessee Valley went on through mostly to New Orleans as the small drafts of the flat boats and keel boats could get over the shoals fairly well and New Orleans was the principal market at that time.

Cross-examination:

The flat boats did not come back. They usually broke them up in New Orleans and sold the lumber and walked back or got back the best way they could.

[fol. 1496] Direct examination continued:

By Mr. Fitts:

"Q. Mr. Alldredge, in your opinion, what class or character of commerce should be given principal consideration in any analysis of the potential value of the Tennessee River for commerce if adequately improved for navigation?

Mr. R. T. Jackson: Just a moment, I object to the qualification of this witness. All he has shown is some connec-

tion with railroad transportation, and I don't think he has shown any qualification for inland waterways improvements or designing them.

Mr. Fitts: I am not asking him a thing on earth about design or about feasibility. I am asking what character of commerce should be considered, and if a man who has spent the time he has, and who has prepared the kind of reports he has prepared right there, is not qualified to testify, I don't know who is.

Judge Allen: The objection is overruled, and you may have your exception. The Court considers that experience in connection with the operation of the Authority as experience.

Mr. R. T. Jackson: May we have an exception?

A. It is undoubtedly the through commerce that should be given consideration because the primary need of the Tennessee Valley from the standpoint of transportation is to get its products out of the region to the markets of the country."

In reaching a conclusion as to the potential value of the improved Tennessee River, it is necessary to consider the Tennessee River as part of the integrated Mississippi and Ohio River systems. I am in agreement with the testimony of Major Putnam who testified on direct examination that the Tennessee River must be considered as integrated with the Mississippi and Ohio River systems.

By Mr. Fitts:

"Q. Will you state what factor should be considered in determining the potential volume of traffic which may be expected to move on the Tennessee River if adequately improved for navigation and interconnected with the Mississippi and Ohio River Systems?

[fol. 1497] Mr. R. T. Jackson: My objection is to the competency of the witness, whether he knows whether it is adequately improved for navigation, and whether he knows under what conditions it attracts commerce.

Mr. Fitts: Of course, the Court understands that the factors to be considered are economic and not physical. The assumption is that the river is going to be improved,

and I am asking this witness to testify, assuming an improved waterway, what economic factors will determine whether traffic will move or not.

Judge Allen: Did your question say 'Economic Factors'?

Mr. Fitts: It did not. I will reframe the question

Judge Allen: The objection is overruled. He may answer.

Mr. R. T. Jackson: May we have our exception, please?

Judge Allen: You may have it.

Mr. R. T. Jackson: That is not an amended question; it is the same question not amended, I understand.

Mr. Fitts: Let me withdraw the question, correct the record and state it this way:

By Mr. Fitts:

Q. Will you state, Mr. Alldredge, what economic factors should be considered in determining the potential volume of traffic which may be expected to move on the Tennessee River, assuming that it is adequately improved for navigation, and assuming that it is interconnected with the Mississippi and Ohio River System?

Mr. R. T. Jackson: We object to the competency of the witness upon the ground that he shows no qualifications for basing any judgment upon what is an adequate improved waterway or any knowledge of what the costs of transportation are, or, consequently, any knowledge of what commerce, if any, would move.

Judge Allen: The objection is overruled.

Mr. R. T. Jackson: Exception, please.

A. Well, in general, all of the economic factors which go to make up the economic environment within which the river will have a function as an integrated stream would be considered. Now, specifically, the abundance, variety and availability of the basic resources contiguous to the stream itself, and the other interconnected streams are one of the factors; the proximity of important commercial centers and [fol. 1498] manufacturing areas to the inland waterways system, the population adjacent to the interconnected streams, and whether or not the directions of these interconnected streams are in harmony with the direction in which traffic ordinarily moves into, out of, and through the valley, and finally the systems of freight charges maintained

by land transportation agencies with which the Tennessee River will have to compete, and with which it may be coordinated. These are, of course, fundamental conditions and they determine whether or not the Tennessee River has sufficient potentialities to justify a traffic survey at all or not. If they are favorable and point to the probability of a substantial tonnage, then the next step is to trace out those possibilities and potentialities in detail and determine what kind and volume of commerce can be attracted to the river and what the savings would amount to."

I have considered and studied the various reports of the Army Engineers dealing with the economic factors considered in the improvement of navigable waterways.

By Mr. Fitts:

"Q. Will you state whether your studies of the documents have indicated to you that the same general method of analysis has been employed in determining the economic feasibility of improving the internal waterways?

Mr. R. T. Jackson: I object to the question as leading, and for the further reason that the witness is wholly incompetent to tell what is the practice of the Army engineers in determining economic feasibility.

Judge Allen: These various reports are in evidence, and the question relates to the reports. The objection is overruled, and you may have your exception.

Mr. R. T. Jackson: Exception. I do not understand the reports state what processes the Army Engineers went through.

Judge Allen: House Document 328 states a good many things.

Mr. R. T. Jackson: Many things, but not that. May we have our exception noted?

A. Well, the most modern and most thorough of these surveys by army engineers do take those factors into consideration in substance. That is true of House Document 328 in large measure.

In my opinion the number and importance of the industrial and commercial centers that may be reached by the Tennessee River and interconnected inland waterways

[fol. 1499] will have an effect on the traffic possibilities of the Tennessee River.

The map (offered and received in evidence as Defendants' Exhibit 118) is entitled "Some Industrial and Commercial Centers Reached by Interior Waterway Systems with Waterway Distances Between Them". The data on which this exhibit is based was obtained from several sources. The general locations of the waterways was obtained from the U. S. Army Engineers' report. The commercial and industrial centers are placed there by a study of the geography of the country and the centers of population are taken from the census of 1930. The stream locations are taken from the United States Army Engineers' reports. It is a diagrammatic chart; it does not follow geographical lines exactly. It shows quite a number of important commercial and industrial centers on the banks of inland waterway systems of which the Tennessee River is a part. These centers are potential traffic originators and the traffic receivers for commerce which may flow to and from the Tennessee River. There are seven important centers on the Tennessee River itself, Knoxville, Chattanooga, Guntersville, Decatur, Florence, Sheffield and Tusculumbia. There are other towns along this river of less importance. Guntersville is not a very large city, but it is just 35 miles from Gadsden, Ala., which is the center of the second largest industrial district of Alabama. Guntersville is connected directly with Gadsden by railroad and highway. On the connecting streams there are many important centers which are daily creating traffic which could move by water and some of which could move to and from the Tennessee River. This system connects at Chicago with the Great Lakes and at New Orleans with the coastal canal which skirts the Gulf of Mexico and ties in some of the important ports along the Gulf. The center of population shown there is in Greene County.

[fol. 1500] "Q. Mr. Alldredge, will you state whether or not there is a substantial population on the Tennessee River and the interconnected waterways and the contiguous territory which could be served in the transportation of freight by means of the improved Tennessee River, assuming that it is improved?

A. Yes, sir.

Q. Without any long movement by land?

Mr. R. T. Jackson: I object to the question as entirely too indefinite and general. This shows connections to Olean, New York, and Duluth, Minnesota.

Judge Allen: The objection is overruled.

Mr. R. T. Jackson: May we have our exception, please?

A. I said, yes, there is a substantial population along these interconnected waterways."

The chart (offered and received in evidence as Defendants' Exhibit 119) is entitled "Population Concentration Along Interior Waterway Systems." The data was obtained from the 1930 census. The strips colored in blue are approximately 50 miles wide, 25 miles from both banks of the stream on either side. The red areas are the large urban counties along the streams, in some instances more than one county being included. The population of these respective counties is shown on the map. It will be noted that about 18.2% of the population of the United States, based on the 1930 census, is located within 25 miles of the interconnected streams. The legend in the lower left-hand corner shows the population along each major subdivision of these waterways, the percentage of that population to the total United States population, and the population per square mile within the blue areas, subject to modification as shown in the notes at the bottom of the legend. The population along the Kentucky and Cumberland Rivers is shown but is not added to the total.

Referring back to Defendants' Exhibit 118, the figures [fol. 1501] along the river are the approximate waterway distances between the river ports.

I have made a study of the products produced in the Tennessee Valley which might be expected to use the waterway for shipment locally in this region and to points outside the valley through the Tennessee River if it were improved for navigation. The chart (offered and received in evidence as Defendants' Exhibit 120) is entitled "Principal crops produced in the Tennessee Valley" and was prepared by me or under my supervision and direction. The data was obtained from the Census of Agriculture of 1933 which is published by the United States Census Bureau from figures prepared by the U. S. Department of Agriculture. It is a government publication.

"Mr. Fitts: The Census of Agriculture. We offer in evidence as Defendants' Exhibit 120 the exhibit just identified by the witness.

Mr. R. T. Jackson: We object to the introduction of exhibit 120 on the grounds first, that it is irrelevant and immaterial; second, that the witness has no competency to testify with reference to the economic feasibility of the waterway, the movement of crops; third, that the exhibit reflects millions of dollars worth of corn which will be destroyed annually by the Tennessee Valley Authority through flooding some 580,000 acres of the best land in the Tennessee Valley, and that, therefore, the statistics are misleading; fourth, because we have been precluded—I don't mean precluded, but the Court has ruled that we may not properly prove the extent to which the crops of the Tennessee Valley are to be destroyed by this enterprise.

Judge Allen: The Court ruled that it would not go into the question of individual damages raised by the various individual witnesses who appeared here. That was the basis of the ruling of the Court. Defendants' Exhibit No. 120 is received and you may have your exception.

Mr. R. T. Jackson: We ask for our exception."

Agriculture undoubtedly offers a part of the potential source of traffic for the Tennessee River locally and for long [fol. 1502] distance hauling. In the earlier history of the region a large part of the traffic which moved on the river came from these sources. There is another inference to be drawn from that map. Those agricultural pursuits also require agricultural implements and machinery, which furnishes another source of traffic moving in the opposite direction to the ordinary movement of agricultural products. In House Document 328, table 2, p. 514, an estimate is made of the agricultural production in 1926 within 5 to 15 miles of the Tennessee River and its tributaries. The estimate was 2,075,430 short tons of agricultural products. In the same area along the main Tennessee River alone, the estimate was 793,940 short tons, which will give some idea as to the probable source of tonnage of those crops.

The chart (offered and received in evidence as Defendants' Exhibit 121) is entitled "Types of forest resources in and around Tennessee Valley". The data was obtained from the official forestry maps published by the Southern

Forestry Experimental Station of the United States Department of Agriculture at New Orleans, except for the state of Tennessee for which there is no existing official map and the information had to be obtained from the Forestry Department of the TVA. The white line defining the limits of the growth of white pine in the area comes from another official source prepared by the Bureau. Forestry has always furnished one of the principal sources of traffic on the Tennessee River. This exhibit illustrates the continued existence of that source of traffic. In House Document 328, table 2, p. 514, an estimate is made of the forest products produced in 1926 within 5 to 15 miles of the Tennessee River and its tributaries and shows that 735,970 short tons of forest products were produced within those [fol. 1503] limits, and along the Tennessee River alone within those limits there was 344,860 short tons. That is a substantial source of traffic.

The chart (offered and received in evidence as Defendants' Exhibit 122) is entitled "Producing centers for some basic minerals in the Tennessee Valley". The data was obtained from several sources, particularly from the minerals map accompanying House Document 328.

Cross-examination:

It is one of the plates in volume 2, but I do not recall the exact number of it. That information has been supplemented and checked by information which is contained in the Minerals Year Book for 1937, published, I think, by the United States Bureau of Mines, Department of the Interior.

Direct examination continued:

In House Document 328, table 1, page 512, the estimate was made of mineral production along the Tennessee River and its tributaries.

Examination by the Court:

The exhibit does not show phosphate mines at Carthage, Tennessee. The phosphate is shown by the crossed symbols as in Middle Tennessee. The cross picks right opposite Carthage indicates phosphate rock operations. I do not think it is very near Carthage.

Direct examination continued:

Carthage is on the Cumberland River east of Nashville and this rock mining of phosphate appears to be on the Cumberland between Nashville and Carthage.

[fol. 1504] Examination by the Court:

Carthage was placed at the end of the white line which is supposed to portray the Cumberland River, I presume to indicate that it was about half way between Carthage and Nashville. Carthage was intended to indicate the end of the Cumberland River. I cannot name the places where the phosphate mines are around Nashville. I know there are mines in that general vicinity but I cannot give the exact location.

Direct examination continued:

“By Mr. Fitts:

Q. Will you explain to the Court what is shown by the exhibit, that is of significance, if anything?

A. It attempts to illustrate that there is a substantial source of potential traffic for the Tennessee River, consisting in these mineral deposits and operations. Now, in House Document 328, table 1, as previously mentioned, an estimate is made—

Judge Allen: What page?

The Witness: I do not know the page, it is table 1. Estimates are made of the availability of minerals along the Tennessee River and its tributaries. According to that table, about 447,500,000 short tons of coal are probably available within a strip of 5 to 15 miles in width along the Tennessee River proper. On the tributaries—

Mr. R. T. Jackson: Just a moment. I move to strike out the statement, it is a mere reading of what is in the report, and acquires no significance from this witness' reading. He is not competent to give an opinion as to whether it would or would not move.

Mr. Fitts: I might call attention of the Court there has been repeated testimony of witnesses on both sides, testifying, summarizing what is contained in House Document 328. I think it is for the convenience of the Court.

Judge Allen: We think it helps the Court to have our attention called to various matters in this rather bulky volume. You do not claim the statement made does not exist?

[fol. 1505] Mr. R. T. Jackson: I do not know. I have not read the volume sufficiently to have in mind that information. I only know this, if your Honor please, the volume is in evidence and certain witnesses have assumed facts there for giving an opinion, which is quite all right. But I do not want this witness going on to add to the testimony by reading from document 328.

Judge Allen: The Court rules the witness may call attention to materials from House Document 328. You may have your exception.

Mr. R. T. Jackson: We except.

A. On the tributaries in the same little strip of territory 5 to 15 miles of the river banks, an estimate of 1,387,500,000 short tons of coal probably available in the future is given. That makes a grand total along both the main river and its tributaries within 15 miles of its banks of 1,835,000,000 short tons of coal that are probably available. The limestone reserves are shown to be inexhaustible and the reserves of phosphate rock within 5 to 15 miles of the tributaries total 92,400,000 short tons.

Mr. R. T. Jackson: May it be understood my objection goes to each of these products as read from the document.

Judge Allen: It may be understood. I call attention again to the fact that in order to keep the record clear we desire specific objections always to be made.

Mr. R. T. Jackson: I was trying to accomplish that in this way.

By Mr. Fitts:

Q. Mr. Alldredge, in your opinion in making an estimate of the traffic potentialities of the Tennessee River, assuming that it is improved, is it important or not to consider the basic commodity products in the various sections which may be reached by the inland waterways system, which could be shipped to the Tennessee Valley region, assuming the river to be navigable?

Mr. R. T. Jackson: I object to any answer on the ground the witness is not competent to determine the economic possibilities of the waterway.

Judge Allen: Objection overruled. The Court bearing in mind that this witness has testified he has studied these questions for four years.

Mr. R. T. Jackson: May we have our exception, please.

Judge Allen: You may have your exception.

[fol. 1506] The Witness: My answer is, it is important."

The map (offered and received in evidence as Defendants' Exhibit 123) is entitled "Map showing traffic producing regions touched by interior waterway system." It is just an ordinary relief map with the publishers shown in the lower right-hand corner.

Cross-examination:

The Bauxite material is taken from the mineral year book, 1937, published by the U. S. Bureau of Mines, p. 665. The coal comes from a map showing coal fields of the United States, published by the U. S. Geological Survey of the Department of the Interior in 1907 and prepared by Mr. Marius Campbell.

Examination by the Court:

There are about 17 sources for this map and about half of them are non-governmental, but they are standard authorities.

Direct examination continued:

The map is not inclusive and is not so intended. It is simply for the purpose of illustrating to the Court that there are within the influence of all these interconnected streams some of the most important primary resources of the United States, and it is a firm foundation for the inference that traffic potentialities exist.

I think it is a clear inference that the geographical setting of the river system including the Tennessee River is distinctly favorable for the development of river traffic.

"Q. In estimating the potentialities of the Tennessee River, as included in the unified plan of the Tennessee Valley Authority in its report to Congress, is it important or not important to consider the basic products of the section reached by the inland waterways?

Mr. R. T. Jackson: I object to that as incompetent.
[fol. 1507] Judge Allen: Objection overruled on the grounds heretofore stated. You may have your exception.

A. It is important, yes."

I have made a study of the movement of the rail traffic moving in and out of the Tennessee Valley and contiguous counties, which might be considered as potential traffic on the Tennessee River if the river is improved. The chart (offered and received in evidence as Defendants' Exhibit 124) is entitled "Railroad freight origins and terminations in Tennessee Valley and contiguous areas, 1932." The data shown thereon was obtained from Appendix 3 of the freight traffic report of the Federal Coordinator of Transportation, issued in 1935. It is intended to show by a consideration of railroad tonnages approximately what the volume of the traffic is to and from this region which the river could draw from when it is completed as a navigation channel. The information is shown in two sections, the one on the left showing the number of cars of freight terminated in counties in the Tennessee Valley area and the contiguous sections during the year 1932, and the section on the right giving the same information for the cars originated in that area. The legend in the lower right hand corner furnishes a basis for interpreting these figures approximately by counties. The report from which the information was gathered shows that the originations of railroad cars containing loaded freight during 1932 in the Tennessee Valley counties was 387,801, and the total terminations were 359,339, giving a grand total of 747,140 cars. In House Document 328 the District Engineer used for 1926 a total of 27,000,000 tons of freight moving into, out of and through the Tennessee Valley, exclusive of perishables and other articles that he thought would not be attracted to the river. [fol. 1508] If the total for the Tennessee Valley, as represented by this chart, is multiplied by the average car loading for the year 1932 in the southeast of 33.54 tons, it will produce a total tonnage of 25,059,075 tons that moved in and out of the Tennessee Valley during the year 1932. Since that time there has been a considerable increase in railroad traffic of nearly 44 per cent and the railroads have lost 16 or 17 per cent of that traffic to the trucks since 1926, and taking that into account, according to my estimates, something over 40,000,000 tons of freight are moving into and out

of the Tennessee Valley counties. In addition to that, there is a very large movement through the valley and there is a larger amount of traffic than the District Engineer actually considered in House Document 328.

I have made an investigation to determine whether or not the general flow of traffic in and out of the valley corresponds to the general direction of the river and the interconnected waterways and have found that the general direction of the flow of traffic would place a large volume of it in the same direction that the rivers go, that is, north and south and from the southeast to the northwest, and vice versa.

The chart (offered and received in evidence as Defendants' Exhibit 125) is entitled "Ton-Miles of Traffic on the Tennessee River, 1933 to 1936". The information came from special graphs covering the Tennessee River tonnage issued by the U. S. District Engineers' office at Nashville. The total of ton-miles was checked against the regular reports of the United States Army Engineers. There are two ways to measure the volume and amount of traffic moving on the waterways or any other transportation agency. One [fol. 1509] is simply by showing the number of tons transported and the other is to use the unit of ton-miles, which shows not only how many tons were transported but also the element of distance in the transportation. That is the best way to illustrate it. The U. S. Army Engineers did not keep their records by ton-miles prior to 1925, but I wanted to show how the traffic which is currently moving on the Tennessee River comes out when it is illustrated by ton-miles, the various groups of commodities. One conclusion that may be drawn from this exhibit is that traffic is increasing, and another is that ton-miles of forest products have on the average more significance than the sand and gravel products which have been spoken of several times. The traffic on the Tennessee has increased from about 32½ million ton-miles in 1933 to about 66 million ton-miles in 1936, and when the river is improved, the ton-miles will increase much faster than the tons because of the increase in haulage.

I have made a separate and independent study to determine which specific commodities could be expected to move on the Tennessee River and in what amounts, and at what savings, if the river is improved as set forth in the TVA plan. These specific studies were conducted during the last three

and one half or four months. The main purpose of it was to check as far as I could the estimate contained in House Document 328 of future tonnage on the river and determine whether or not the changes that have occurred in the character of the traffic which moves, when the circumstances surrounding its movement would depreciate in any way the estimates which House Document 328 contained. The U. S. District Engineer in his survey relied very largely upon information obtained from railroad business. That was not [fol. 1510] available to me, so I proceeded first, with the consideration of the general conditions affecting the flow of traffic into, out of, and through the valley, and then analyzed all of the pertinent sources of information that we could get hold of concerning the actual movement of traffic, and then I went to shippers and receivers of freight, commercial organizations and others who have knowledge of the freight actually moving into and out of the valley, and from that information we compiled our estimate.

The table (offered and received in evidence as Defendants' Exhibit 126) is entitled "Estimate of Tonnage Movement on Tennessee River for 1937, Assuming Complete Navigation Facilities", and reflects the summary of these studies. In the case of two groups of commodities, coal and coke and forest products, I was not able within the limitations of time and the facilities which I had to work from, to make a detailed estimate of those tonnages, so I examined the information furnished as supplements to House Document 328 concerning those commodities and formed an over-all judgment, and in this summary I have simply included the tonnage and savings relating to coal and coke and forest products that were published in House Document 328, all of which is shown in the notes on the table. In the case of the present annual tonnage, I took the average for four years from 1936 back and made an estimate on the savings that were effected through the transportation of those materials on the river at the present time. In so far as this exhibit shows facts, they are true and accurate, and in so far as it is a matter of estimate, it represents my best judgment. This exhibit is based upon 1937 traffic.

[fol. 1511] "Mr. Fitts: We offer in evidence as Defendants' Exhibit No. 126 the table just identified by the witness.

Mr. R. T. Jackson: We object on the grounds that the witness is not competent either to estimate what tonnage might move by water, or to determine the nature of the waterway involved from a navigation standpoint, or to estimate savings by water transportation."

Examination by the Court:

As to what my definition was in making this estimate of complete navigation facilities, so far as I was concerned in making the estimate, I meant the complete canalization of the river from the mouth to Knoxville for navigation purposes. I did not take into consideration any particular form of canalization. I didn't go to that extent.

Direct examination continued:

By Mr. Fitts:

"Q. In other words, in so far as these estimates are concerned, as I understand it, you estimate that these would move whether the river were canalized by high or low dams?

Mr. R. T. Jackson: I object.

By Mr. Fitts:

Q. So long as it is canalized?

A. So long as it is canalized and the service is established.

Judge Allen: The exhibit is received and you may have your exception.

Mr. R. T. Jackson: Note our exception.

By Mr. Fitts:

Q. Mr. Alldredge, will you state whether or not in your opinion the estimated totals set forth in Defendants' Exhibit No. 126 represent a reasonable and conservative estimate of the annual movements, annual savings and average savings which could be expected if the Tennessee River were improved for navigation by a canalized channel from the mouth to Knoxville?

[fol. 1512] Mr. R. T. Jackson: I object to the competency of the witness to answer the question upon the grounds

previously stated, and upon the further ground that he has already answered the same question.

Judge Allen: He may answer.

Mr. R. T. Jackson: Exception noted, please.

A. There were tonnages that we came in contact with that we could not trace out because of limitations in time. Then, again, as to the savings, we used a conservative formula in determining the savings in the first instance, and in the second place, railroad transportation charges, that is, railroad freight charges are right now in the process of being substantially increased. There was a considerable increase on a number of commodities that went into effect on November 15th. We could not incorporate these increases in these railroad charges. Another group of commodities were increased effective December 20th, and we did not get these increases in here. Then, the railroads have a general petition pending before the Interstate Commerce Commission which is now being heard, asking for a further increase generally on all commodities of about 15 per cent."

Cross-examination:

I did not put in what they are asking for now. I did not get any of those recent increases in there. I think they would have shown an increase in the savings here if I had.

Direct examination continued:

The savings by water transportation and the average savings per ton as shown in the last two columns of Defendants' Exhibit 126 were computed by taking the existing railroad freight rates applicable to the particular commodities as far as we could between the exact points between which they moved, and when we could not do that we took contiguous points that were affected by approximately the same level of railroad charges. Then on most of it we applied the formula prescribed by the Interstate Commerce [fol. 1513] Commission in the making of joint haul rates between railroads and boat lines, which is frequently referred to as the 10 and 20 per cent formula, except when you get so far beyond the limits of circuitry that the 20 per cent would not apply. That is a conservative formula which was specifically prescribed to apply to joint haul movements between water lines and rail lines. It was applied to those

movements and, except in one or two instances, we used it also on the all-water hauls. We know that all-water charges are not regulated, they can make any rates they want to, but that is a common carrier formula and frequently the contract carriers cut much below those levels. In the case of gasoline, which is transported more by contract and private carriers than it is by common carriers, we used a different formula, but generally speaking, we used four mills per ton-mile for the distance transported by water to the major bulk terminals on the river, and then on that gasoline that goes out to the subsidiary filling stations or storage stations, we added to the water rate a rate equivalent to about two cents per ton-mile for transportation by truck.

It is not possible to make a worth-while estimate of the value and savings to shippers resulting from the improvement of the Tennessee River for through navigation without considering rail rates charged the shippers, because the rates are the things that the shippers and receivers pay and not the costs, and if there are any savings to be effected, they come about in the difference in the rates and not in the costs. As far as the Tennessee River is concerned, there is [fol. 1514] another element in the situation. Railroad rates are not made in direct relation to costs of service, and I have never heard of any rates on any other transportation agency being made in that way. In using the railroad rates as a base from which to calculate the savings, there is a peculiar situation in the United States. We have no national freight rate structure on the railroads; it is a regionalized structure, and the southeastern region is separate from that standpoint, and the railroad freight charges are considerably higher in that region than they are in the territory just north within which such rivers as the Illinois and the Ohio operate, so that there is an opportunity in the region on the Tennessee River to effect a greater margin of saving by the use of the river as compared with the railroad charges than there is on some of the other rivers.

I am the author of House Document 264, 75th Congress, First Session, entitled, "Inter-territorial Freight Rate Problems of the United States" and I have made a study of the relative unit costs of transportation services by water, rail and truck to determine whether the use of rail and water rates is or is not a conservative method of estimating transportation savings.

The chart (offered and received in evidence as Defendants' Exhibit 127) is entitled "Comparative Unit Function Costs, 1932", and was prepared by me or under my supervision and direction. The sources from which this information was obtained are indicated on the body of the chart and they are official reports prepared and published by the Federal Coordinator of Transportation.

[fol. 1515] "Mr. Fitts: We offer in evidence as Defendants' Exhibit No. 127 the chart just identified by the witness.

Mr. R. T. Jackson: We object to it because, in so far as, if at all, it purports to be any expression of opinion by the witness, we object to his competency to compute costs with reference to water transportation, and if it is merely a reproduction of certain data or graphs that have been published in some reports we object for the reason that there is no showing what they cover or what they include, and they are not intelligible and would be misleading, introduced by a witness who knows nothing about them.

Judge Allen: The objection is overruled. The Court bears in mind that the witness, Mr. Alldredge, has studied these matters for four years in connection with the work of the Authority and has reported on certain phases of them in public documents.

Mr. R. T. Jackson: May we have an exception, and if the ruling is based upon any public document may we see the public document which is referred to?

Mr. Fitts: You certainly may. (Handing book to counsel.) I would like at this time to ask the Court to take judicial notice of the report which I referred to which is an official House Document, and which I think is clearly within the rule of judicial notice. It is here and I will be glad to furnish copies. I don't care to offer it in evidence because I don't think all of the report is relevant but I think the fact that he made it is.

Mr. R. T. Jackson: If it is being offered as an exhibit—

Mr. Fitts: I am not offering it as an exhibit because I don't think all of the material contained in it is relevant, but I think the fact that the witness made the report and made the study is relevant, so long as a challenge as to his qualifications has been made.

Judge Allen: That is in evidence, Mr. Fitts, the fact that he made the report is in evidence; you asked him that question and he said yes, he wrote the report.

Mr. Fitts: Of course that does not show what it is.

Mr. R. T. Jackson: No, it doesn't show anything except he wrote something.

Judge Allen: He wrote a public report, as I understand it, which was presented to the Congress.

[fol. 1515a] Mr. R. T. Jackson: That is right, but whether it is in relation to what he is testifying about or has any bearing on his qualifications does not appear.

Judge Allen: The Court considers that the testimony of this witness as admitted is competent upon the ground that a statistician of the experience of this witness is not compelled to engage actively, physically, in every business which he studies; because he makes an exhaustive study of the various sources and material which relate to the matters that he studies, he is entitled to testify and his testimony is competent. He is entitled to give his opinion and the objection goes to the weight rather than to the competency of the evidence.

Mr. R. T. Jackson: If it please the Court, I understand that was the ruling the Court had made, but I am merely preserving the record.

Judge Allen: The Court is merely preserving the record as to the reason why it considers this question competent. We consider him to be a statistical expert. We consider that he worked for four years and is experienced in that line."

This exhibit has a bearing upon the issue of rates as a basis for estimating the transportation savings, because in making comparisons of rates as between water carriers, for instance, and rail carriers, in order to know what the margin [fol. 1516] of difference in cost of the operation of carriers is, it gives an outside limit when the difference in rates is considered and that is what we have used in this exhibit. The official report from which this was made indicates that all costs of operation in the case of railroads and water carriers were considered, except expense for capital service such as bond interest which was not included. It is more what might be termed operating expense than anything else. Function cost is mostly operating cost. The inland waterways car lot carriers were mostly common carriers. The division of the black part of the bar indicating a cost of 3.4 mills per ton miles represents the average cost by water distance. Mr. Eastman made an adjustment of these

costs so as to compensate for the extra circuit of water lines as compared to rail hauls, and indicated for that purpose the figure of 5.5 mills. That is adjusted to the rail distance. As I interpret his report, it did not say so in so many words, those distances are really short line distances. The costs shown in the bar at the extreme right are divided in the same way. According to my check of his study, he included all Class I railroads, which are the larger railroads having an annual operating income of a million dollars or more; and in the case of water carriers, not all of them were included, they were simply representative. The freight traffic report, Vol. 1, is a study that Mr. Eastman made of transportation of freight traffic.

The table (offered and received in evidence as Defendants' Exhibit 128) shows the ratio of transportation savings by use of the Tennessee River, and transportation charges by all railroad routes on data obtained from the recent traffic [fol. 1517] survey. It was prepared by me or under my direction and the sources used were the same as those for Defendants' Exhibit 126, except that the savings are computed into terms of percentage ratios. The facts stated thereon are correct and the estimates are my best estimates.

"Mr. Fitts: We offer in evidence as Defendants' Exhibit No. 128 the tabular statement showing 'Ratio of transportation savings by use of Tennessee River.'

Mr. R. T. Jackson: Let the record show the same objection to the competency of the witness, the ruling and exception.

Judge Allen: Objection overruled. You may have your exception."

I formerly worked out my calculations of the percentage of savings in total cost of transportation that may be obtained by using this waterway on a per tonnage basis. This was simply converted, instead of showing what percentage of difference there is between the all rail tons to that between the charges by rail and charges by all water or by rail and water. The ratio of savings as shown on this exhibit is in my opinion conservative. The formula I used in working out the savings was conservative to begin with. I checked it against the savings as actually effected in the use of water transportation on other streams and it proves conservative from that standpoint.

The table (offered and received in evidence as Defendants' Exhibit 129) is entitled "Rail Freight Traffic, Southern District." The source from which I obtained the material was from the statistical reports of the Interstate Commerce Commission, except for the estimate for 1937 which came from the bulletins issued by the Association of American Railroads, and that is an estimate. In predicting the future growth of traffic set forth in House Document 328, the District Engineer said something about the rail [fol. 1518] traffic curve as one of the bases for his prediction. That rail traffic curve went down when the depression hit the country, and it subsequently started back up. I wanted to show the Court just how that curve is acting in relation to the estimate which the District Engineer made. There has been a slight recession in November and December of 1937.

"By Mr. Fitts:

Q. I will ask you whether in your opinion it is reasonable or unreasonable to expect a substantial increase in the amount of commerce beyond the amount which you have estimated for 1937, which might move on the Tennessee River if improved for navigation?

Mr. R. T. Jackson: I object to that question, object to the competency of the witness, and on the further ground I do not think he has even estimated the commerce to move on the Tennessee River.

Mr. Fitts: The witness has made all his estimates based on 1937 alone. Your witnesses made estimates projected into the future. I am merely asking whether an increase may be expected.

Judge Allen: Objection overruled. The witness may answer.

Mr. R. T. Jackson: Note an exception.

The Witness: My opinion is it is reasonable to expect an increase."

The chart (offered and received in evidence as Defendants' Exhibit 130) entitled "Tonnage Actual and Estimated, Moving on Mississippi River System Since 1914" was prepared by me or under my supervision and direction. After a most diligent search ever since I have been with the TVA, I was unable to find an accurate official report of tonnages moving on the Mississippi River system from the beginning"

of the use of these rivers. We have undertaken, after the expenditure of quite some time, to work out such an estimate. This exhibit is based, as far as we can go, upon the total figures reported by the Army Engineers and the [fol. 1519] U. S. Census Bureau. When we could not get the complete figures, we used the partial figures from those official sources and made an estimate so that the trend might be visualized.

Examination by the Court:

All of the bars shown in the dark colors are the official figures and those shown in light or white colors are the estimated figures. The information was obtained from official reports of the Army Engineers wherever possible, but these are not complete for all the years which are indicated by the white bars. The source for the material for the years prior to the War of 1812 was from reports kept by official trade bodies in such cities as St. Louis, New Orleans and sometimes Cincinnati, and then we would check those figures against the total years that we could get and work out this estimate in that manner.

Direct examination continued:

We did not go to all of those places but we sought all the reliable information obtainable. The biggest difficulty we had was during the Civil War years and this exhibit is not absolutely reliable for those years for commercial traffic. Most of the boat lines were commandeered by either the Union Government or by the Confederacy and used for the transportation of war materials. We did the best we could about it and in my judgment that is the best estimate that could be made from said sources.

"Mr. Fitts: With that explanation we offer in evidence as Defendants' Exhibit 130 the exhibit on the standard, entitled 'Tonnage actual and estimated moving on Mississippi River system since 1814.'

[fol. 1520] Mr. R. T. Jackson: We object, so far as showing estimated tonnage, as being entirely speculative, incompetent, irrelevant and immaterial. As a matter of fact, it is difficult to understand why there is so much white on there, because it covers many years when to my knowledge there are reports.

Judge Allen: The Court deems this exhibit as illustrative of the witness' opinion with reference to the matters there estimated. Since the differentiation is clearly shown in the colors between estimates complete and incomplete, the Court does not consider it misleading.

Mr. R. T. Jackson: Exception.

Judge Allen: You may have your exception."

Examination by the Court:

The freight traffic on the railroads in the area of the Mississippi River system as far back as the year 1888, when the Interstate Commerce Commission was created, has grown steadily until about 1923, and since that time the tendency has been somewhat downward. The growth went up slightly during the boom period of 1926 to 1929 and then started down again and hit bottom along about 1932 when it started back up again. In recent years it is acting differently from the trend shown for all waterways, which have been steadily up and the railroad curves in the last dozen years or more have shown indications of going the other way.

Direct examination continued:

In my opinion, an estimate of the transportation charges on the freight actually transported on the Tennessee River does not accurately reflect the full value of this improvement for navigation in relation to movement in interstate commerce. To the extent that it stimulates the growth of industry and business, there is an intangible element of value, [fol. 1521] and frequently a waterway will cause a reduction in railroad rates, sometimes at right angles to the waterway, and these things result from the influence of water transportation, but are not taken into consideration in the calculations of these savings. The Mississippi River has traditionally had an effect upon the level of railroad freight rates in the Mississippi Valley.

In my studies of the movement of traffic around the Tennessee Valley region, I found a substantial movement in and out of the city of Chattanooga.

"Q. In your opinion, what effect, if any, would the provision of a nine foot channel on the Tennessee River from Knoxville to the mouth of the river have on the movement

of traffic between the states within the influence of the Tennessee River and the interconnected inland waterways?

Mr. R. T. Jackson: Just a moment. I renew my same objection on the same grounds as to the competency of the witness.

Judge Allen: Overruled upon the same grounds.

Mr. R. T. Jackson: Exception noted.

A. Well, it would serve to increase the volume of traffic, in my judgment."

Examination by the Court:

With regard to the existence of phosphate rock between Nashville and Carthage, in the Minerals Year Book of 1937 published by the Bureau of Mines of the U. S. Department of the Interior, at p. 1319, there is a reference to the production of phosphate rock in the State of Tennessee which shows that the production in 1936 took place in Maury, Sumner, Giles, Davidson, Hickman and Perry Counties and the production in Sumner County in 1935 was given as 14,763 tons which is not very heavy.

[fol. 1522] Cross-examination:

I graduated from a small school in Alabama known as the Central Alabama Agricultural School. It would not be a college today. It is not a college. I did not study there agricultural studies chiefly. They had agriculture in the course, but that was not the chief one. I did not take any course in engineering at that school or anywhere else. That was more of a general educational school. After I left the agricultural school I was not a shipping clerk for Penick and Ford in Montgomery. I never worked for Penick and Ford. That company you are trying to get a hold of was the Southern Syrup Company whose main product was molasses and syrup, and then I worked with a canning company. During that period I was secretary and manager of the freight bureau at the Montgomery Chamber of Commerce. That was extra work. I was in Montgomery about a year. Then I went to become Secretary of the Dothan, Alabama, Chamber of Commerce.

"Q. How large was Dothan at that time?

A. Oh, about 17,000 or 18,000 people.

Q. Well, it was only 16,000 in 1930, wasn't it?

A. I don't know exactly; I haven't checked that up.

Q. Was it the result of the Chamber of Commerce efforts that it went backwards, or was that about the size of the town?

A. I was just giving you an approximation. It is a very thriving little city."

Then for a year I was with the Atlanta & St. Andrews Bay Railroad. That is a short road about 100 miles long. From there I went with the Alabama Public Service Commission to become director of the Bureau of Transportation. In the meantime I had studied law and become a member of the bar. I was with the Alabama Commission for 12 years [fol. 1522a] until 1934. The Alabama Public Service Commission dealt with rates of all transportation agencies, in- [fol. 1523] cluding the boat lines. It also dealt with power rates. Power rates were not in my field, but the Commission dealt with them. The Alabama Commission regulated the rates of water carriers, but not only in connection with rail carriers. They regulated all of these rates where they were in common carrier service. When I first went with the Commission, there were several boats in common carrier service. By the time I left not all of them were gone. I joined the TVA on September 1, 1934. I wrote a book entitled "Ratemaking for Common Carriers." There is no chapter in that book specifically on water carriers. I said in there though that the general principles which I discussed would apply to boat line rates.

Defendants' Exhibit 127 shows mills per ton-mile for railroad transportation of Class I railroads. That is the average. I am familiar with the Class I freight rates but there are more than 12 classes. This exhibit is not limited to railroads in southern territory but refers to Class I railroads all over the United States. These costs are average costs for the hauling of all freight. They include the same kind of freight that is included in all classes of tariff schedules. They include all kinds of high priced merchandise that is shipped in less than carload lots, carries a relatively high freight rate and involves relatively high handling costs, but the tonnage of that type of freight is the minor part of the railroad business. It includes additional costs by way of insurance or liability on transportation of those high grade manufactured articles which are shipped in these high freight classifications. It also includes

the costs of handling and the insurance costs involved in perishable articles shipped under high freight schedules [fol. 1524] and the costs of refrigeration for food products and things of that kind. That is part of the operating cost. There are commodities which are carried at commodity rates which are relatively speaking very low. Those articles include coal and crushed stone and things of that character. All heavy bulk freight is moved in large quantities. Those are usually carried at the lowest rates, but I am not sure that they are carried at the lowest costs always. I am familiar with the fact that the great coal-carrying railroads such as the Chesapeake & Ohio and the Norfolk & Western made the largest profits throughout the depression. Where coal constitutes a very large part of railroad tonnage, the railroads can organize their schedules in such a way as to effect the lowest possible cost of operation, but where you throw in a car of coal now and then, I am not so sure that the cost would be much lower than of the other freight. As to whether I can tell any commodity other than that which is carried at commodity rates, such as coal, crushed stone, and those big, bulky commodities carried in open freight cars, can be carried more cheaply by the railroads, you have opened up a great big question. You are speaking on the average and in general, I suppose. I can name the commodities but I want to name the circumstances and conditions. Sand and gravel in some circumstances and under some conditions phosphate rock. Sand and gravel is one of the big bulky commodities carried at commodity rates when they are carried by railroads at all. As to whether I can name a commodity that is not included in one of the big, bulky commodities moved by the railroads at commodity rates which a railroad can ordinarily move more cheaply than such bulky commodities [fol. 1525] ties, I don't know that I could name one that they could haul more cheaply as a general rule where they are properly organized, but I understand that special circumstances surrounding the movement of the commodities sometimes affect very materially the cost. One can find high cost operations of all kinds by looking for them.

I used a blanket 10-20 per cent differential on the basis of rulings of the Interstate Commerce Commission. I am familiar with the fact that the power to set a differential for a joint rail-water common carrier rate is vested in the

Interstate Commerce Commission by Sec. 15 of the Interstate Commerce Act.

Section 15A of the Interstate Commerce Act provides that the Commission may prescribe minimum differentials between all-rail rates and joint rail-water rates for common carriers so long as they are reasonable. I do not know that the purpose of that provision is to keep the all-rail rate high enough above the joint rail-water rate so that joint rail-water transportation will not be driven out. I never knew of the Interstate Commerce Commission raising the all-rail rate so that it would be 20 per cent higher than the joint rail-water rate. Assuming that the costs of water transportation and transfer of the joint rail-water movement were more than 80 per cent of the all-rail rate, it would not be possible to pay the operating expenses and the wages of the crew out of that formula if the service was devoted exclusively to joint haul service. It might be possible to serve that for less than cost if there were other means for making up expenses. It is sometimes done in case of railroad and trucking operations. The Interstate [fol. 1526] Commerce Commission may fix a reasonable differential between all-rail rates and the rail-water rate when in a particular case it finds on an examination of the facts that it is justified.

On Defendants' Exhibit 122 the distance from Knoxville to Memphis by the river route is 919 miles and by the all-rail route the distance is 424 miles, making it 217 per cent as far by water. Considering the Tennessee River by itself, as disassociated from its connections, I do not know of any large river in the eastern United States or east of the Rockies which has as large a circuitry factor, as indirect a route, as the Tennessee River, starting from its head at Knoxville to its mouth.

At the present time the large movement of inland water commerce consists chiefly of heavy bulk commodities such as coal, sand and gravel, crushed rock, iron ore and things of that character, but that does not mean it is going to continue that way. It is a fact that inland water transportation is peculiarly suited to the movement of heavy bulk commodities of that character, but that is partly due to the fact that transportation charges constitute such a high proportion of the destination values on those wholly crude commodities and makes them more sensitive to transporta-

tion charges. Those are the first ones to seek the methods of economy. It is also true that package freight or merchandise requires relatively larger expense in handling and re-handling and also requires speedier transportation. Even with the splendid direct water transportation by deep water between such ports as Charleston and Savannah, practically no package freight movement has ever developed and it is almost entirely carried by rail. I think water haul is more [fol. 1527] suitable to long haul of goods than it is to short haul. The answer would have been different if New York had been involved. There is a great deal of package freight between New York and Savannah moving by water. As to whether I want to testify that package freight between New York and Savannah moves chiefly by water, I have not made any exact comparison as to the amount which moves but I do know there has been a continuous movement of package freight from New York down the coast to such cities as Charleston and Savannah for many years. The movement of that package freight is not all confined to cities along the Atlantic coast which have no railroad but that freight goes as far west as the Mississippi River.

There are four or five transportation economists in my division of the TVA. They are not just young helpers. They are all well qualified. Referring to Defendants' Exhibit 118, I could not say how much traffic now moves by water between Chicago and Evansville, Ind. I have not segregated it that way. As to whether I know it is a fact that there is none, I have not made an examination of the question to find out how much traffic goes from Chicago to Evansville. I think there is a 9 foot channel from Chicago to Evansville. The improvement of the Tennessee River will not in any way affect the movement of traffic between Chicago and Evansville. It might affect and probably would affect the movement of traffic from Chicago and Evansville to Tennessee River points and in the reverse direction. I also show Duluth on the map. I do not anticipate that any particular water traffic would develop between Duluth and Knoxville. That is not just a little frill. It showed traffic could move by water that way. Traffic could go from Olean to New [fol. 1528] York around by Australia and back up the Mississippi if somebody wanted to pay the charges.

Defendants' Exhibit 122 shows some extensive coal deposits in the vicinity of Pittsburgh, but it was not intended to indicate coal deposits as much as it was to show the pro-

ducing centers. Referring to Defendants' Exhibit 118, I do not anticipate a large movement of coal from Knoxville to Pittsburgh, there will not be much carrying of coal to New Castle, but there might be a movement of coal to Minneapolis, St. Paul or Kansas City, places like that where they need it. There is no coal now moving to Minneapolis and St. Paul. We have had inquiries about it. They have been inquiring about getting coke down on the Tennessee. There are extensive coal fields in Illinois comparatively close to the Illinois River, but I do not know whether coal is shipped from those coal fields to Chicago. They could ship coal from those coal fields to Minneapolis if they got the coal. I do not think it is better coal than around Knoxville. There is a complete analysis of the groups of coal around Knoxville in House Document 328. A casual examination of that shows that the coal in East Tennessee is a little superior to the Illinois coal. I know there is a large movement and that all of the coal used at Duluth and most at Minneapolis and St. Paul is shipped by boat up the Great Lakes as a return cargo for ore boats coming down. I know that there are literally hundreds of boats going up the Great Lakes empty from the ore ports on Lake Erie to Duluth for ore. It is true they carry coal if they can get any at very low rates if anybody sells it and wants to ship it. I do not know of any refusal to sell to them but I think the [fol. 1529] East Tennessee mines could do some selling too and might take advantage of that when the river is canalized up to there. I did not make a detailed study of how much coal I expected to move from the Knoxville area to Cincinnati, but I did study the potentialities. The coal for Cincinnati comes from either the West Kentucky mines or the mines up on the Kanawha, the Monongahela or the Ohio River. I am not sure about the superiority of the coal on the Kanawha River, but they can load directly from the mines into the river boats. I think that very thing will happen when the Tennessee River reaches the Cumberland Mountains coming up towards Knoxville. I do not know of any large coal mines below Knoxville where the tipples empty into the river, but I know coal is in there, and when boat lines started operating on the Tennessee River in the early days, most were coaled on the upper reaches of the river from mines on the banks of the river. I never knew of any which carried coal to Cincinnati.

I do not recall whether there is any map which would indicate that there is any coal in Iowa. Defendants' Exhibit 123 shows lead and coal.

"Q. Why don't you show coal in Iowa?

A. Well, we did not undertake to show all of those places.

Q. If you showed coal in Iowa it would not look much like Omaha and Sioux City would get coal from Knoxville?

A. I am not so sure of that. It depends on the grade of coal, and sale prices."

I showed some coal in the extreme southern tip of Illinois running over into Kentucky. I know that some of the coal fields in central Illinois are shipping directly on the Illinois River. As to why I did not show the coal fields in Indiana, [fol. 1530] we simply were not trying to show everything. As to showing only a little coal in the corner of Pennsylvania, the word "coal" is written on the Appalachian Mountains on the map to show that there is coal there. I admit there is coal in the Appalachian Mountains. As to why I did not show coal in Michigan and North and South Dakota, I did not have any purpose in showing that. As to whether I was showing only what I had a purpose to show, the purpose was simply to show the Court that there is a varied amount of primary resources touched by this stream which could be developed into traffic increase. If I had undertaken to catalogue all these, it would have taken me a long time and I could not have gotten them all upon the map.

Defendants' Exhibit 122 shows the basic minerals in the Tennessee Valley, including coal, limestone, phosphate rock deposits and mines, and Defendants' Exhibit 123 shows that one of the great resources is marble. Both of these are right. There is some other mineral up there that we did not show too. It is simply illustrative.

Defendants' Exhibit 121 shows a general outline of the forest area in the Tennessee Valley region. This does not mean that it is all forest land, but that there is some forest. To have differentiated between the cleared land and uncleared land would have brought me into such minute descriptions that it would have been confusing rather than clarifying. There are a good many woods left in this basin and they are being cut and marketed. When we build this immense Gilbertsville reservoir, all of the forest which are within that reservoir area will have to be cut down and

the same is true with reference to all the other TVA reservoirs up the river and on the tributaries, and all the woods [fol. 1531] will be destroyed where they are within the reservoirs. The reservoir areas are not more than half wooded. I do not know how many acres. As to whether I regard that as an act of conservation, considering all the elements of it, I think it is very much an act of conservation.

Defendants' Exhibit 119 shows the population per square mile. The Chicago population was not included on the Illinois system because I felt it should be more properly included within the influence of transportation on the Great Lakes rather than on the Mississippi. Chicago is the principal contributor to water traffic on the Illinois system. The population of the three counties in and around Chicago is shown on the map itself, but has not been computed in terms of population per square mile. In making my calculation of population per square mile for the area below Baton Rouge, I did not include New Orleans because I felt that the population as far as the 30 foot channel extends should be counted within the influence of the Gulf Coast transportation, but I have no objection to it being computed on that basis. There is a very large proportion of traffic in that section of the river.

Of the total tonnage moved on the Tennessee River in 1936, the supplies, materials and equipment in connection with the construction and maintenance of the works of the TVA and other government freight was 54.1 per cent of the total, which is taken either from the figures of the District Engineer at Nashville or from the report of the Chief of Engineers, and it includes the traffic at Gunter'sville of the Louisville & Nashville ferry. Excluding that crossing the river, it was 55.7 per cent. I guess practically all that government freight is TVA freight. I have not gone into [fol. 1532] that question in detail. but it is very probably mostly TVA freight. As to what part of the 1937 freight on the river was TVA freight, the figures for the 1937 freight have not been compiled as yet. I do not know whether they are larger than for 1936. Possibly more operations were carried on by the TVA. I don't keep up closely with those engineering operations. I cannot give the percentage in ton-miles of the TVA or government freight for 1936. It has not been compiled by anybody that I know of. We do not keep any records of the percentage of government freight in ton-miles. It is a better way to keep

[fol. 1538] mean on the exhibit when you get outside of the counties which are wholly white that there was no traffic and no railroads, but merely that I did not extend this study to those counties.

With reference to Defendants' Exhibit 125, I cannot give the tonnage, source and destination of TVA traffic by classes of commodities for 1936. I did not have to have that in order to compile the exhibit. I did not have to have TVA traffic to determine the ton-miles, the kind of traffic and what its source and destination were. I had a graph which indicated the movement of all traffic but not with the TVA traffic segregated. I am unable to explain that with relation to TVA traffic. The information for 1936 I obtained from special graphs furnished by the U. S. District Engineer. The report of the Chief of Engineers for the year 1936 has not been furnished yet. I have no objection to furnishing the special official graph from which I obtained this information.

With reference to Defendants' Exhibit 125, I cannot tell how much of the increase in forest products in 1936 is lumber or timber for TVA forms, construction camps or other uses, but from my general knowledge of the movement of forest products on the Tennessee River, I think it is a minor part.

On Defendants' Exhibit 126, I show an out-bound movement of 878,000 tons of iron and steel. It is expected that this very large movement will be shipped out of Chattanooga, Gunter'sville, Birmingham, and Muscle Shoals. Birmingham is not on the Tennessee River, but it can reach the Tennessee River. Birmingham steel will be shipped either through Sheffield, Decatur or Gunter'sville. There are no suitable terminal facilities at these various locations for handling this movement at the present time. They [fol. 1539] will have to be constructed. It would require some time for that to be done and it would have to be done before the traffic could develop.

As to whether I know of any waterway in the United States where there exists a movement in iron and steel having any such relation to the total traffic as that shown in my estimates for the Tennessee on my Exhibit 126, there is an important movement on the Ohio. I do not know whether the percentage of the iron and steel traffic on the Ohio to the total traffic is as large as this or not. There is an im-

portant movement on the Mississippi too. The proportion of iron and steel moving on the Ohio is nowhere near as large in proportion to the total traffic as I have estimated for the Tennessee. I do not think the percentage would be as great.

As to naming locations along the Tennessee River at which I estimate movement of coal and coke, that movement was taken from House Document 328. All I did was take the figure out of House Document 328. I made no detailed study of the points of origin, terminals or anything of that kind in connection with that movement. There is a very large movement of coal in, out of and through the Tennessee Valley. Major Watkins analyzed that carefully and determined what he thought would be a reasonable percentage of that to move by the Tennessee River. There are possibilities also of the opening up of mines right along the banks of the river after it is canalized, which would furnish an additional source of traffic for the Tennessee River.

The movement of forest products on Defendants' Exhibit 126 was likewise one of the items taken from House Document 328, but I did make a more extensive study of that than I did of the coal. I know that lumber moves generally on [fol. 1540] the Tennessee and has moved for years from the river banks below Florence. That area is not very well served by railroads and a great deal of that lumber is hauled in to the banks of the river and shipped out. I know that the forest resources extend all along the river from near its mouth to the head waters at Knoxville, and potential lumber traffic might originate at any place along the river almost throughout its entire length. I estimate that local lumber might be logged and taken to the river anywhere along the stream. There is a constant flow of lumber from the Southeast, reaching as far as the Gulf of Mexico, on through to the Tennessee Valley to points in the North, and some of that traffic could very well be handled in connection with railroad transportation to some place like Chattanooga, Decatur or Muscle Shoals, and then forwarded on by the Tennessee River and its connections. I could not say as to whether it is generally true that the history of the movement of forest products on all rivers has been that lumber along the banks has been cut off first and then the movement by water of forest products has steadily declined. I have made some investigation of the Tennessee and can say that the creation of these deep reservoirs will

back navigable water into places where it makes more economically accessible timber resources that heretofore have had to come out by expensive truck movements and brings the possibility of cheap transportation for logging to additional areas closer to the water. On p. 114 of the history which I wrote of the Tennessee River, I show that the forest product movement on the Tennessee River has had a decline after the boom of earlier years after the best timber has been cut off along the stream. I do not say that it is characteristic. It is partly due to the fact that what [fol. 1541] they used to call merchantable timber has declined and other uses for the timber are being created and other kinds of forest products are now moving more largely than they used to.

On Defendants' Exhibit 127, I said that Comparative Unit Function Costs were substantially the same as operating costs. Fixed charges such as interest, depreciation and taxes are a substantial item in the costs of any kind of transportation, particularly with railroads. I did not base my estimate of savings by water transportation directly on anything shown on Defendants' Exhibit 127. My estimates were based upon rates and not upon costs.

Defendants' Exhibit 128 shows a movement of 100,000 tons of cement and a total of all water cost of \$272,000. That estimate does not include cement that is currently moved on the lower Tennessee, but represents probable new traffic originating largely in the Chattanooga District. The probable destinations were Decatur, Florence, Paducah, Memphis, Vicksburg and New Orleans. We took the existing all-rail rates from Chattanooga to those points and then figured the all-water rate at 80 per cent of that and used the difference as the measure of the savings by water. The average is approximately \$.68 a ton and 100,000 tons at a savings of \$.68 a ton makes a total saving by water of \$68,000. We simply took 80 per cent of the rail rates and called that the charge for water transportation and said the difference was the saving which is a very conservative figure in my judgment. Sand and gravel which is a special movement of a kind of sand and gravel known as Tripoli, appearing in very large quantities along the banks of Bear Creek, was not estimated in that way. It moves both as an industrial raw material and the movement upon which that [fol. 1542] saving is figured is from Iuka, Mississippi, to Florence, Alabama, and then the savings is determined upon

the 80 per cent basis. It is true that the all-water or rail-water cost on sand and gravel was derived simply by taking 80 per cent of the all-rail rate, but that is not true of the present sand and gravel which is in another category entirely. The charge for all-water or rail-water transportation of the item of iron and steel is based upon the same formula. That is also true for sugar, which nearly all comes from the New Orleans Refining District and goes all up and down the river.

The short line rail distance between New Orleans and Knoxville is 441 miles and the water distance is 1,377 miles. That is figuring the water distance against the short line railroad distance, but freight moving on railroads does not always move by the short line. Generally speaking on all railroads there is a circuitry of movement. The circuitry factor between Knoxville and New Orleans is about three to one, figuring the all-water distance against the short line rail distance. I do not know exactly the circuitry factor for the sugar movement between New Orleans and St. Louis but it is less than three to one. I would not assume that a differential between all-rail and rail-water rates on the Mississippi could be applied more or less blindly to the rate situation on the Tennessee even though circuitry factors and density of population factors are very different. I have in substance applied the 80 per cent formula to practically every commodity except clay and gasoline. That cost exhibit which I filed here allows ample latitude for that.

The present sand and gravel movement shows a very much greater saving, one of the factors of which is due to [fol. 1543] the fact that the sand and gravel is dredged out of the river and transported on barges to the site where it is used. The other factor is that if it moved at all, it would have to move largely by trucks. There are no land facilities that are handy for moving sand and gravel from those particular points. There would be truck haulage but not rail haulage. One reason for the greater saving on the present movement of cement is due to the fact that much of it is for TVA uses and its destination is right in the river at the dams where there are no good land transportation facilities. We took that into consideration.

It is frequently true that rail rates for lines which parallel inland waterways are materially lower than those for feeder or traverse lines. That is just one of the intangible benefits of water transportation which I mentioned. It is a com-

mon practice for railroads to reduce their rates on specific commodities even below actual cost of transportation, to meet water competition. I don't know what the Interstate Commerce Commission is going to do hereafter about that, but they have been doing it for years. I know that it is necessary to provide rates for the railroads sufficient to keep them running. Some of them may go into bankruptcy in the meantime and come out again, but in the long run that is the way it is supposed to work out. No formula has been developed for operating the railroads at a permanent deficit and still keeping them going. Some of them have been in the hands of receivers for several years.

"Q. Now, if you compute savings on the basis that shippers merely pay the operating costs of the vessels on inland waterways, and the nation or the public pays the fixed charges and the operating expenses of the waterways themselves, is there any justification from the national or public viewpoint of claiming alleged savings based on a comparison of just operating costs of the barge owners and ignoring the fixed charges paid by the public?

[fol. 1544] Mr. Fitts: We object to that question, may it please the Court. It calls for the witness' conclusion on a matter of policy.

Mr. R. T. Jackson: It is an economic justification, whether there is any economic justification.

Judge Allen: The objection is sustained. You may have your exception.

Mr. R. T. Jackson: May we have our exception noted, please.

By Mr. Jackson:

Q. Is it not a fact that the mere granting of a subsidy to shippers on waterways does not constitute an economic saving from the standpoint of the nation?

Mr. Fly: We object, may it please the Court, upon the ground that he is now questioning the witness for opinions and statements and conclusions as to policy.

Mr. R. T. Jackson: I don't think so.

Mr. Fly: It is a question purely for Congress to determine.

Judge Allen: The objection is sustained, and you may have your exception.

Mr. R. T. Jackson: Exception noted, please."

On Defendants' Exhibit 128, the movement of 505,000 tons of gasoline and kerosene at an all-water or rail-water charge of \$2,506,000 is in the St. Louis and Baton Rouge Districts. The principal receiving points we estimated on the Tennessee would be Muscle Shoals, Decatur, Gunter'sville, Chattanooga and Knoxville, but there would be intermediate places such as Perryville. I made up a table (offered and received in evidence as Defendants' Exhibit 131) that shows tonnage which I estimate would be delivered at these points. The basis upon which I computed the all-water or rail-water charges for a movement of this amount of gasoline and kerosene was four mills per ton-mile. That figure was based upon a consideration of the rates charged by contract carriers for the movement of gasoline on the Mississippi and Ohio Rivers, and from a consideration also of the costs of transportation by contract carriers as represented by the exhibit which I have filed here, and also on the general towing tariff published by the Federal Barge Lines. The exhibit to which I referred is Defendants' Exhibit 127, Comparative Unit Function Costs. The gasoline-kerosene movement is 15 per cent to 20 per cent of my total estimated movement. I looked into the matter of approximately how much of the total traffic moving by water on the Ohio River consisted of gasoline and kerosene expressed in percentage. I did not base my estimates strictly on such considerations as that. I went into the conditions in the Tennessee Valley itself and discussed the matter with the purchasers and distributors of gasoline and I discussed it with representatives of oil refining companies. The experience on another waterway which has been developed for a considerable time is a good index, if you take into consideration all the differentiating circumstances and conditions, which would include increased population, circuitry, and other things. As to whether it is not a fact that the gasoline-kerosene tonnage on the Ohio River does not exceed 5 per cent of the total water traffic, including duplications, it is about 8.4 per cent in 1936. As to whether I am quoting unpublished figures for 1936, the 1937 official figures have not yet come out from the office of the Chief of Engineers, but I do have the 1936 figures on the Tennessee and Ohio. As to whether the figure 8.4 per cent, which I purport to

quote is based on some unpublished figure or the figures reported in the 1936 report which covers the data for 1935, I notice I have a letter from Colonel Powell, Chief Division Engineer at Cincinnati, dated November 24, 1937. I presume he has given me some figures. I do not recall whether I got my estimate of 8.4 per cent from the last official report [fol. 1546] of the Chief of Engineers, but they are official figures of the Chief of Engineers. I got them one way or another.

Examination by the Court:

Sometimes the unpublished figures which I receive from the Army Engineers are preliminary. Occasionally we can get those figures from one of the Division Officers, before they are actually publicly announced in Washington. None of the figures are received from anyone except the Army Engineers. All we get from the Army Engineers are in an unpublished state.

Cross-examination continued:

I cannot say whether I took the 8 per cent from the published report of 1936. I have not my notes here. The published reports show that the percentage ranges from 2.5 per cent in 1931 to a maximum of 5.5 per cent in 1935, which would be contained in the 1936 report of the Chief of Army Engineers, and I can very well understand that it would increase the next year.

I would not say that the circuitry factor, population factor and industrial factor are more favorable for the movement of gasoline on the Ohio River than on the Tennessee River from the points which I have indicated as points of origin. The circuitry factor from Baton Rouge to Gunter'sville is worse than from Baton Rouge to Cincinnati, but that is an extreme one. That would not be true on gasoline coming from Wood River, Illinois, to Tennessee River points.

Defendants' Exhibit 130 shows the actual and estimated tonnage moving on the Mississippi River system since 1814. I cannot tell exactly what tributaries of the Mississippi River system I used for 1817, but so far as we could observe [fol. 1547] it, we used the same streams as are included in Table 70, p. 28, of the report of the Chief of Engineers for 1936. It is largely the Mississippi River and its navigable

tributaries. The Chief of Engineers has been publishing annually the commercial statistics for a great many years. I do not know just when it started, but it has only been since about 1924 that he has been publishing a total net figure with duplications eliminated. One of the difficulties with the old statistics is that there were duplications when they were added together. For the years 1920 through 1923 and 1928 through 1936, the figures are reported as complete with duplications eliminated in the annual report of the Chief of Engineers. The figure for 1916, 1906, 1886, and 1880 are special canvasses from the Bureau of Census. For 1889, the figures are included in the census for 1890. The figures shown in black are taken directly from one of the reports I have indicated and the others are estimates I made from one source or another and from the partial figures published by the Army Engineers whenever I was able to find them. I did not make any use of Defendants' Exhibit 130 in any testimony I have given, but I want it to support my judgment that I expressed that there would be, when the river is canalized to Knoxville, a future increase in tonnage.

Redirect examination:

The circuitry factor is determined by comparing the actual distance by water between two points with the shortest rail distance. Freight does not move by the shortest routes by railroads. This circuitry factor is not a fair representation [fol. 1548] of the difference in distance when it is checked against the short railroad lines. There was no through channel on the Tennessee River in the past.

The graph (offered and received in evidence as Defendants' Exhibit 132) is entitled "Tennessee River Tonnage Graph 1936" and was prepared by the United States District Engineers' Office at Nashville, Tennessee, dated April 19, 1937, and shows graphically the movement of different tonnages on the Tennessee River classified into several groups of traffic. It is from this that I procured the data as to the ton-miles on the different groups of commodities.

Recross examination:

In comparing the all-water route with the all-rail route, I mean the shortest all-rail route. The circuitry factor oper-

ates the same when applied to one point as another. In almost any case, there is more than one rail route that is possible. Freight frequently moves by the indirect route. That is true of practically any two points as far as railroads are concerned, but the water carriers have to stay in the channel and they do not usually have alternate routes.

(The witness was excused.)

[fol. 1549] PERCY H. THOMAS was called as a witness on behalf of the defendants and, having been first duly sworn, was examined and testified as follows:

Direct examination:

I am 65 years of age, reside in Atlanta, Georgia. I am an engineer on the staff of the Federal Power Commission, but I am not testifying in that capacity today. In explanation of my status in this case, the Acting Chairman of the Commission has given me permission to make a study in certain lines in connection with this case and granted me permission to testify in my personal capacity as an engineer.

I graduated from the Massachusetts Institute of Technology in 1893 with the degree of Bachelor of Science in electrical engineering. After a year or so in the apprentice course with the Westinghouse Electric & Manufacturing Company, I became a member of the Engineering Department of that company. For the next nine years, until 1903, I was busy on a mixture of research work and commercial design, as this was the pioneer period in the early development of alternating current. However, I had much opportunity to investigate practical problems of high tension transmission. At that time I presented several technical papers on the subjects before the national society of electrical engineers, the American Institute of Electrical Engineers. One of these treated of "static strains" in electric circuits, and I was afterward invited to present the subject matter before the Franklin Institute of Philadelphia, and was awarded the Franklin medal therefor.

Following 1903, I was for four years chief electrician for the Cooper-Hewitt Company, this being a personal enterprise of George Westinghouse, engaged in developing mercury vapor rectifiers and lamps. In 1907 I formed a partner-

[fol. 1550] ship with N. J. Neall, of Boston, to practice consulting engineering. During the next few years I was very active in the American Institute of Electrical Engineers, in which society I have served as manager and vice-president and have held at one time or another the position of chairman of nearly all the standing committees. That society has a Committee on Power Transmission, now known as the Committee on Transmission and Distribution, the chairmanship of which I have held many times.

In 1913 I was engaged by the firm of Guggenheim Brothers to design a transmission line for their large copper mine project in Chile. This led to my appointment as consulting electrical engineer for the firm, in responsible charge of the engineering for their power interests in South America, which included both hydro and steam systems and extensive transmissions and power supply for the Chile Exploration Company, the Braden Copper Company, and the Caracoles Tin Company of Bolivia. During this period I undertook for the firm the design of other hydro transmission projects, one for the city of Santiago, Chile. On the disbanding of the Guggenheim Brothers Engineering staff in 1923, I returned to consulting engineering, in which work I continued until 1934, with a wide variety of clients, largely on electrical power problems.

In 1934 I joined the staff of the National Power Survey under the Federal Power Commission, as chief of the Power Requirements Division. In January 1937, I was appointed regional director of the Atlanta office of that Commission. This office covers eleven southeastern states, Virginia, North and South Carolina, Georgia, Florida, Alabama, Mississippi, Tennessee, Kentucky, Arkansas and Louisiana. The Power Requirements Division, in cooperation with the Power Resources Division of the National Power Survey, planned for the collection of data of the proper character and in sufficient quantity to permit the analyses and study [fol. 1551] of the operations and plants of the utilities of the country, their inter-company and interstate operations, the prospects of regional shortages or surpluses of power, efficiencies of operation, adequacy of facilities, and so forth. These data were collected in the form of questionnaires sent by the Commission to the utilities in the country and are now pretty well known. As regional director of the Atlanta office of the Commission, my duties, in addition to

it, but we do not have it. I don't say that the percentage on a ton-mile basis on government freight for 1936 would be greater than the percentage on the total basis. I do know that a very large part of the non-government movement on the Tennessee is sand and gravel, but I think the TVA has moved some sand and gravel too. I know the non-government sand and gravel movement is a very short haul, but it is a little longer than on some rivers in some cases.

With reference to Defendants' Exhibit 123, I have heard of the great limestone producing areas at Calcita, Michigan, but I did not show them on this exhibit. These three exhibits I have been talking about covering forests, agriculture and minerals are simply designed to show what the resources are in the Tennessee Valley and they have no reference to anything very far outside of the valley. As to whether I am familiar with the iron ore deposits at Marquette, Michigan, and also Northern Wisconsin, those are the ones in the Mesabi range. The Mesabi range is in Minnesota. I thought these deposits in Michigan and Wisconsin were the same deposits as in the Mesabi Range in [fol. 1533] Minnesota. I don't show those on that either. I think most of that goes to Pittsburgh.

I am generally familiar with the great gasoline industry at Whiting, Indiana, but I do not show that either. I do not show anything about petroleum in either Michigan or Pennsylvania. I do not think there are any petroleum resources at Whiting, Indiana. I think that that oil is brought in there from somewhere else. The gasoline shown on Defendants' Exhibit 123 over on the Chesapeake Bay is an unfortunate word. It should have been the word "Petroleum". A small amount of petroleum is produced in Pennsylvania. It is produced at Oil City in Pennsylvania and I know about where that is.

If Defendants' Exhibit 123 shows an apparent concentration of minerals and other resources around the Tennessee River to which I do not agree, it was not so intended. I could not agree that it really does show an untrue concentration of minerals in the Tennessee Valley. What I meant by the exhibit is that future traffic, when the Tennessee River is canalized and harnessed up, might well draw on some of the resources in the other regions. I think petroleum originating down in the southwest is just as much a source of potential traffic to the Tennessee River as the marble which you see there and more. I am quite sure that they

are going to trade coal and one thing and another, and I am quite sure that gasoline coming from the petroleum reserves in the southwest will be moving on the Tennessee River in six months. I do not know that corn is raised in Ohio and other points contiguous to the Ohio Valley and some of that may come up the Tennessee River, too. I don't think they are going to use more corn down here.

[fol. 1534] I do not have my tonnages broken down and I cannot tell exactly if it is correct to say that the movement of agricultural products such as corn and grain of all kinds on the Ohio River has ranged since 1932 in the vicinity of 3/100 of 1 per cent up to perhaps 15/100 of 1 per cent of the total traffic. I observed that the tonnage on the Ohio of grain and grain products, cereals and rice, is undoubtedly small. Since 1934 the official Army reports do not give the total amount of packet freight separated from the other groups, and the unclassified groups have ranged from about 5 per cent in 1934 to about 3.69 per cent of the total tonnage carried on that stream in 1936. I presume those articles are included in the unclassified group. I think that the reports of the Chief of Engineers show separately cereals, grain, feed, oats and grain products, but I have not got those figures before me. I would not dispute the fact that the largest percentage shown in those reports is 15/100 of 1 per cent of the total movement on the Ohio River, because I don't know. I did not know that before I made the estimate shown on Defendants' Exhibit 128 of potential tonnage on the Tennessee River, when I showed grain and grain products, cereals and rice, amounting to substantially more than 10 per cent of the total annual tonnage; but the situation is different between the Tennessee Valley and the region served by the Ohio with respect to those articles of freight. As to why it is different, the Tennessee Valley is largely a deficit area with respect to the production of those commodities, and it must bring in great quantities of them to meet its own consumption requirements. There has been a steady flow of grain and grain products from the Middle [fol. 1535] West into the Southeast ever since I can remember. I showed on the exhibit that there are a good many agricultural products in the Tennessee Valley and I presume that the great Pittsburgh and Cincinnati areas are deficit areas in the matter of producing grain and foods which they consume and use, but not on the lower Ohio.

There is approximately the same population in the Pittsburgh area alone that there is in the entire Tennessee Valley. Defendants' Exhibit 119 shows the population of the Pittsburgh area alone is 2,221,000 and the population of the Tennessee Valley is about 2,800,000. The concentrated populations in the Tennessee Valley are two, 155,000 and 159,000. The figure I have on the lower left hand legend of Defendants' Exhibit 119, Tennessee River, 1,329,048 population for 1930. That is the population within 25 miles of both banks of the Tennessee River. But that is not all of the Tennessee Valley. The Pittsburgh population is located within even a more restricted area, but the first question you asked me was in relation to the population of the Pittsburgh district and the Tennessee Valley.

I do not have the livestock tonnages, which are shipped on inland waterways, segregated by themselves. Livestock is sometimes shipped by barge on the Tennessee River now, but it is not shipped extensively. I think there is a small movement every year. It used to be shipped extensively for the days when they took the flat-boats down and walked back and also since the coming of steamboats. It would not take as long as 100 hours to ship livestock from Paducah to Knoxville by barge. In the report of the Chief of Engineers for 1932, the character of the livestock movement on the Tennessee River is shown as from Knoxville to Paducah, a total of cattle of three tons and of hogs, four tons, which is about the minimum. It is not close to the maximum. For 1933 the report of the Chief of Engineers shows one ton of cattle and two tons of hogs, but I recall a full barge load coming up locally last year. I don't know whether they got into the figures or not, but they came in the river a short distance.

I do not have the figures separated for the percentage of traffic for the lower Mississippi River consisting of forest products. I think forest products make a rather small percentage of the total traffic on the Illinois or Ohio Rivers and it is very much smaller than I have shown on the exhibit for the Tennessee River, but we have very substantial and positive sources of forest products as river traffic in the Tennessee Valley regardless of what they have on the other rivers. I show about 30 per cent of forest products. I think Major Putnam showed something like that too.

On Defendants' Exhibit 122, I show some phosphate mines which appear to be on the map right on the Cumberland River near Nashville. I don't recall any phosphate moving on the Cumberland River during the last few years. Some moved on the Tennessee. None moved on the Cumberland that I recall.

On Defendants' Exhibit 124 I show the county in which Memphis is located as one that would ship and receive over 150,000 car loads per year. That is not an accurate index of traffic in the Tennessee Valley. It is not in the Tennessee Valley, but it is connected and will be connected by water with the Tennessee Valley when the Tennessee River [fol. 1537] is canalized. A great deal of the Memphis traffic moves North and South on the Mississippi River and also back and forth to the West, but it also ships to and from the Tennessee Valley. I also show Birmingham as in one of the counties that will ship and receive over 100,000 car loads. It is not located in the Tennessee Valley, but is just below the edge of it. A great deal of its traffic is shipped to the South and other directions and a great deal goes North and comes in from the North. A great deal does not go North or come in from the North.

As to whether these counties I have marked are the ones I selected as having some bearing on my estimates, they don't have as much to do with it as the larger counties. Defendants' Exhibit 124 shows in the lower right hand corner certain lines by which it can be determined how many cars are shipped in and out of certain counties. Those lines do not appear upon a very large number of the counties shown on the maps. What I mean is that in my judgment the counties that do have lines in them are more directly related to the influence of the Tennessee River for navigation purposes than the other counties. As you increase the distance you get more and more remote. Hardin and Perry Counties which are entirely white are right on the Tennessee River. That means that those counties do not have a railroad at all or do not have a class I railroad that reported these figures. That explains all the white counties which are intermingled with the counties that are some way marked. I did not mean that the ones that are outside are too remote to receive any detailed study from me, but in the case of some particular county, there is some traffic which it is possible to reach as far as Florida. I did not

administrative matters, include the study of the conditions as to power supply in the region, and the study of problems on the same subject matter as they arise. I am a fellow of the American Institute of Electrical Engineers and a full member of the American Society of Mechanical Engineers. I have presented many technical papers before these and other societies.

In addition to my general experience, some 10 or 12 years ago William Spencer Murray was appointed by the Secretary of the Interior to make a study of the economies and savings to be made by a hypothetical interconnection of the major utilities on the Atlantic Seaboard between Washington and Boston, a Congressional appropriation being made for that purpose. I acted as Mr. Murray's consultant on transmission and interconnections for this study, known as the Super-power Report. During the War I acted as consultant for Mr. Frederic Darlington, Chief of the Power Section of the War Industries Board. This work turned principally on the shortage of power and the possibilities of interconnection. For this work I hold one of the \$1 checks issued to the so-called dollar-a-year men.

In 1924 the American Institute of Electric Engineers held its summer convention in Birmingham, Alabama. The Chairman of the Papers Committee asked me to prepare a paper on Interconnection for that meeting, and I did so, putting some three months' personal work on it. The paper covered a forecast of the growth of load in the southeastern [fol. 1552] states, principally Alabama, Tennessee, Georgia, and North and South Carolina, and the devising of a system of high tension transmission lines to interconnect and integrate the whole region, using many hydro sites not then in use but projected. This paper recommended a new type of interconnection, known as network. This is well known now but was little heard of then. The subsequent development of this region has followed this network plan.

In my work with the Federal Power Commission, it has been necessary to make one or two studies of a similar nature covering other groups of utilities in this country, one including most of the companies involved in the TVA region. This has never been released for publication.

As Regional Director of the Federal Power Commission, the whole southeastern states came under my jurisdiction. I am reasonably familiar with the principal utility systems in the territory around the Tennessee Valley. I have made

I would say at least three studies with respect to the adequacy of the facilities of the interconnected utility companies in the Tennessee Valley, including the complainant companies, to meet and supply the prospective demands for electric service. The first study I have in mind was made early in 1935, to determine the probable adequacy of electric power facilities in the region centering around the Tennessee Valley. It included Virginia, North Carolina, South Carolina, Georgia, Tennessee and Alabama, and it ran over a little into Mississippi. The study was based on reports from the utilities in answer to the questionnaires of the Federal Power Commission to which I have referred, and consisted in determining the available dependable capacity in the hands of these utilities, and a study of how much of that would be available, how much would be required for reserves, and to find out the amount actually available for delivering load, and comparing that with the probable demand in 1937 for power in that region. I might say that I took the year 1937 because when that study was made, that [fol. 1553] would be the earliest date at which new construction undertaken in 1935 would come into actual service. That study showed a very considerable shortage of capacity to be anticipated in 1937. That assumed that 1937 would be a dry year.

In speaking of dependable capacity, I used the technical word and by that I mean, speaking of hydro machines, the capacity you can count on in the driest year which comes along. I have taken the trouble to make the comparison of the loads reported in 1936 for the companies used in that study and that exceeds by a little over 4 per cent the estimates which I gathered from the company reports for 1937. The figures from the same sources for 1937 are not yet available, but there are preliminary figures which make it appear that my figures for the demand in 1937 are something like 6 per cent below the actual results. My figures for 1936 were 4% below the actual demand and for 1937, 6% below the actual demand which occurred. There has been no genuine scarcity of power, because 1937 has not been a dry year, but those estimates are all on the assumption that we will have a dry year.

I have recently made a study of the present and prospective load requirements and generating and transmitting facilities of the principal private utilities in this area, including the complainant companies and interconnected com-

panies, and the probable adequacy of such generating capacity to supply these complainants for all of their needs; that is, as to whether there is a potential surplus, or potential shortage of power. Although I have not studied the systems of all of the complainant companies, I have taken the view of what I call the system planner, the person who is held to be responsible for looking ahead and advising the company for whom he is working as to what should be done to secure an adequacy of supply. Obviously, it is necessary to look ahead by the length of time it takes to design and install facilities, and this period is from one to two years. In this case I made a study of two different years, [fol. 1554] 1939, since that year is about as early a time as the plants now under construction in this region could be assumed to be in operation, and 1943, which is far enough in the future to count on the full program of the seven power dams of the TVA being completed for use.

I have considered all of the complainant companies in this study and have made studies only of those of the list which are both within reasonable transmission distance of the TVA dams and at the same time have sufficient importance in load requirements to make it worth while to study them, although there is one exception. I studied one group of plants where the output is not of material importance, which consists of a portion of a semi-interconnected system of a greater total load. There are eight companies which are closely interconnected. They are the Commonwealth & Southern group, Alabama Power Company, Birmingham Electric Company, Gulf Power Company, Mississippi Power Company, South Carolina Power Company, Tennessee Electric Power Company, Southern Tennessee Power Company and Georgia Power Company. There is another group of interconnected companies, all of them being subsidiaries of Electric Bond & Share Company, the Arkansas Power & Light, Louisiana Power & Light Company, Memphis Power & Light Company, Mississippi Power & Light, West Tennessee Power & Light Company. There is another group of subsidiary companies, subsidiaries of the National Power & Light Company,—the Carolina Power & Light, Western Division, and the Tennessee Public Service Company. The National Power & Light group is not physically related to the Electric Bond & Share group, but I believe it is related in the ultimate control. There is another group in the Pineville District of the Kentucky Utilities,—the Old Dominion

Power Company and the Dixie Power & Light Company. I believe that the systems I have selected are those of the complainant companies and affiliated, interconnected companies with the minor exception of the Kentucky Utilities [fol. 1555] group. My studies show a probable shortage of firm power in the systems of these utilities.

Before referring to the actual figures on the document (offered and received in evidence as Defendants' Exhibit 133) I would like to make some explanations. Where a group of systems are adjacent and thoroughly interconnected with transmission lines and make a practice of the interchange of power for the purpose of giving the most efficient over-all operation, I have considered those systems as a group, and have produced figures only for the group as a whole. The shortages which I have found in this Exhibit are more properly shortages of energy rather than shortages of capacity.

In view of the great importance of the distinction between energy and capacity in these studies of the adequacy of facilities, I would like to explain the distinction a little more clearly. To furnish an adequate supply of electric power for general use it is necessary to consider both the phase of capacity and the phase of energy. Capacity represents the ability of the generating facilities to meet the maximum demand that may occur on them. Energy refers to the coal burned to produce steam or the water flowing through the water wheels which is necessary to drive the generators from one end of the year to the other. The maximum capacity is required about once a year on the day of the peak and the energy consumed is not known until the end of the last day in the year. These two phases have entirely different characteristics and must be considered separately, and I have found that the chief limitation of most of these groups was the limitation of energy.

The capacity of hydro machines may not be available in a dry year, even though it is entirely capable of carrying its full load with water in sufficient quantity in the rivers. The importance of this distinction is that a system has to have adequate machine capacity for its load during any minute in the year of plentiful water, whereas in a year of [fol. 1556] dry water it would not be able to carry its load, even though the load was no greater and it still had the

same machine capacity as before. It will not be sufficient unless there is a sufficient steam capacity in the system.

The first two left hand columns on Defendants' Exhibit 133 marked "Purchased Energy Requirements", give the summary figures of energy that will be required in 1939 and 1943, which is the energy which these companies must secure somewhere in addition to their own facilities for the loads which I have forecasted they will have to meet. The next columns toward the right under the heading "Purchased capacity requirements" are under the head "Delivery of firm energy", which means that if some company, possibly the TVA, is furnishing a large amount of energy, such as 564,300,000 kilowatt hours to some neighboring company, it requires a certain amount of capacity to supply that energy. The energy has to flow through the machines, and the capacity of the machines which are adequate to deliver the energy is the capacity shown in this column. That is, when we discover that this amount of energy must be supplied, then it will be found that it cannot be done without the presence of 261,700 kilowatts, shown under the 1939 heading in these columns.

Examination by the Court:

These are figures which I have arrived at by calculation, but they include estimates. They are my own figures. They necessarily are estimates because they are for 1939 and 1943.

"Judge Allen: The Court suggests that there be added to the legend "Estimated" or something to show that this is an estimate."

[fol. 1557] Direct examination continued:

This study, like most of my other studies, is based on the questionnaire returns to the Federal Power Commission from the utilities as to their operations, capacities and other facilities. That data has been put together by recognized methods of computation and compilation to produce certain results with a minimum amount of the use of discretion. It is necessary to use a certain amount of discretion and to forecast, but use has been made of all known methods and devices for getting proper conclusions from these figures. These are the figures which are made up by the companies

themselves and reported officially to the Federal Power Commission. The Commonwealth & Southern group of companies are thoroughly interconnected and are operated in a common interest in such a way that if one has power and the other has not, power is transferred and perhaps returned at another time, but in any case they are operated under a single control in the general interest. In the same way the second group, marked Electric Bond & Share, is composed of companies that are very closely related in operation, and each depends on capacity from the others in such a way that a study of the operation of the group separately would have no significance. The same may be said of the National Power & Light group and of the Kentucky Utilities group. For these particular years for which I have made the study, it is usually a shortage of energy—not in the case of the Kentucky Utilities group, but in the others. There is also a shortage of capacity, but the significant thing is the shortage of energy.

The column under the heading "Machine Shortage Including Reserves" is a consideration of the available machine capacity, not taking into account any limitation of water in the hydro machines. While it is possible that the [fol. 1558] shortage of water may be the limiting factor, it is also possible that the limitation of machine capacity might be a limiting factor, and this table shows my conclusions on that matter. The shortage here is after the allowance of the reserves necessary to every system to give reliable service.

The last two columns marked "overall" are compiled from the columns to the left and simply show as an overall matter what capacity must be provided by the companies by this time if all of their requirements are to be met from the several points of view. The figures in the last column are the figures found in the four columns to the left, the largest figures are selected, and I am referring there to a new supply that must be furnished, not to the total supply including capacity and energy already provided. It is in addition to existing facilities. All these figures relate to firm power which must be backed up by the necessary reserves so that it is actually firm, even when the shortage of energy is made up by purchase. There would be no distinction between firm power and firm capacity with regard to the necessity of providing adequate reserve. The sum totals of the energy requirements for the four groups in 1939 are

770,900,000 kilowatt hours and for 1943, 2,169,500,000 kilowatt hours. In order that the supplier of such quantities of energy shall be able to supply them under the conditions in which they must be received, there will be required 380,300 kilowatts for 1939 delivery and 746,000 kilowatts for 1943 delivery.

The machine shortage is 310,200 kilowatts in 1939, but that shortage is covered by the 380,000 kilowatt supply to be purchased. The figure for 1943 is 787,500 kilowatts. To meet both machine shortages and the capacity necessary for delivering energy shortages will require 395,300 kilowatts in 1939 and 816,900 kilowatts in 1943. These figures are based upon the dry year, two dry years being chosen as [fol. 1559] typical, 1936 for the so-called Electric Bond & Share group and 1931 for the other groups. I am under this limitation, that to make these studies by the method I have used, it is necessary to have detailed data, and these are the driest years for which we have such detailed data. They are not by any means the driest years to be expected. When drier years occur, the shortages will be larger and the system planner will have to consider whether the cost of providing further reserve or further purchases than I have shown here will be justified by the cost. The shortage of capacity shown here for Commonwealth & Southern does not include the 2,000 kilowatt contract that that company has for delivery from the South Carolina Electric & Gas Company.

The reason why there is such a discrepancy between the machine capacity of a hydro plant and the dependable capacity which can be gotten from it in a dry year, is that when once a dam has been constructed and a reservoir and power house provided, the increment cost of putting more capacity in that power house is a relatively small matter, and it is found that it is well worth while to put in such additional capacity because that can be used in all years but the very dry years, and such power will be cheaper than power produced by steam. So it has been customary to provide such extra hydro capacity over and above what can be supplied in a dry year. It doesn't represent poor planning or anything of that sort, but is a natural development in laying out these systems.

The Commonwealth & Southern group has by far the larger portion of the totals I have shown, and the National Power & Light group are wholly dominated by hydro ca-

capacity. The Electric Bond & Share group has a small proportionate amount of hydro power and the Kentucky Utilities has practically none. I may summarize by saying that the two figures in the lower right hand corner of the table [fol. 1560] indicate, if my conclusions are correct, what must be provided by this group of companies if they are to give adequate service with appropriate reserves when these years come. Those are my estimates of the new and additional power supply which these companies in my opinion will require.

(The legend on Defendants' Exhibit 133 was thereupon changed to read "estimated additional power requirements".)

Cross-examination:

The heading "Machine Shortage including Reserve" represents the difference between my estimates of what the load will be and the present installation, taking account of the firm non-cancellable contracts.

Direct examination continued:

In my opinion I believe there will be further growth in load in the years beyond 1943 which may reasonably be expected.

The Commonwealth & Southern group and the National Power & Light group are predominantly hydro. The Electric Bond & Share group has a small proportion of hydro, and the Kentucky Utilities group practically none.

I considered the systems of all the complainant companies, but on Defendants' Exhibit 133 I excluded those which did not seem to be in reasonable distance of the dams of the TVA, taking account of the size of the loads of these companies, and I excluded only those which approached only those TVA dams which do not supply firm power.

In connection with Defendants' Exhibit 133, the figures which are shown there relate to the so-called firm power, [fol. 1561] that is, power that can be relied upon at any time regardless of low water in the rivers or other contingencies. It so happens that in most systems with hydro, it is possible to supply large quantities of cheap power most of the time. Where it is possible to use that power to shut down the steam generating units in the neighborhood, it is

possible obviously to save the cost of the coal being burned and other incidental costs. This is worth while, because the hydro energy costs practically nothing, as the machines are already in place. A great deal of such power is used in this region and it is called "steam replacement power". I speak of that in connection with this table because whatever steam replacement power we may use is over and above the figures shown in Defendants' Exhibit 133. The desirability of steam replacement power would be in direct ratio to the cost of production prevailing at the different steam plants.

As the matter of reserves, which I have shown on Defendants' Exhibit 133, plays a very important part in the determination of the adequacy of facilities and in shortages, I would like to explain rather carefully the point of view that I have taken. "Reserves", as I have used it and as I think it is generally used, serves to cover a large number of contingencies of various kinds which may upset a plant's balance between facilities available and the demand. Of these contingencies, one of the most important is difficulty with the generating apparatus, which is by far the most sensitive, complicated and difficult to handle of all the facilities in the power systems. This is especially true of steam apparatus. A large sized steam turbine has to be overhauled, cleaned and inspected often, even though it has not broken down. It is like a high-class automobile. You cannot wait for anything to happen, but you must have it looked over once in a while, and the oil changed and things of that kind. To properly overhaul a large sized steam turbine takes many weeks, and if anything serious has to [fol. 1562] be done, it takes some months. In the same way, to thoroughly overhaul steam boilers may take many weeks. Other contingencies may happen, transmission lines and other parts of the apparatus fail, so it is not possible to count on the use of all of the machines at the same time. When the largest unit in the system is down for inspection, an accident may throw the next largest machine out of operation. By accident, I mean possibly a mistake of the operator, lightning coming into the station, the failure of a protective device, or many other things which do happen in the best regulated power houses. That would mean the two largest machines out of service, but in figuring the

reserve, it is not necessary to take such an exaggerated condition, although it might happen.

I have been in the habit of taking one to one and one-half times the capacity of the largest units as the measure of the reserve that must be provided against the failure of the generators and apparatus connected with the generators. Shortage may be produced by failure of the transmission line over which power may come to the system, or other parts of the system might give trouble. It is not necessary to enumerate the other casualties. I have been in the habit of using more or less 5% as a measure to cover this type, in addition to that representing the breakdown of the generators which is a type of machinery by itself. Within this 5%, I am inclined to include one or more general factors. In a large system like this Commonwealth & Southern group, it is not possible to have such a perfect operating organization that every machine can be run at 100% of its capacity and no more at the particular time it may be needed. It may be somewhat near approximating it, but it is not reasonable to expect perfection. So there is a little allowance which I include in this 5% for contingencies of that sort. There are other sources of difficulty, such as predicting ahead the vagaries of the flow of water in a stream. There may be a dry September or a dry November, and until it comes, you cannot tell what it is. That is a contingency which has to be included in this general 5%.

There is another group of uncertainties that must be allowed for. These questions are, of course, matters of very great importance to the system planner. He is looking ahead two or more years, according to his particular problem in hand, and he has to forecast what the trend of the growth of his load will be. That is usually what they call a straight line or constant rate of increase that he expects for the next few years. Experience shows industrial conditions vary and that they progress, first a little higher and then a little lower. I am not referring to business cycles, but the changes of a few months at a time, with variations up and down. Unfortunately the capacity has to be available for any temporary increase, even though for a short time, and that requires a certain small increase in reserve.

There is also this problem, that the system planner picks 1940, perhaps, and he lays his plans, "Well, I have machines

which will carry us to 1940''. Perhaps the next time he is going to balance his books will be 1942. He must put in enough capacity in his 1940 program to carry him to 1942, which means the capacity over and above the 1940 requirement. Another matter, when he comes to get his bids, making the designs, even at the time of the actual selection of the type of machines he is going to put in, he must buy an economical machine which fits his situation in an economical manner and which will not be less than the growth of his load. He will often buy considerably larger machines than are required to meet his requirements, though it will meet his power for the time. All those things must be taken into account, and I have been in the habit of using about $7\frac{1}{2}\%$ [fol. 1564] of the capacity to represent that contingency.

That appears to cover the provisions for reserves, but there are certain considerations which must be taken into account of a general nature and predominate even over those figures. One of these is this, that the system planner has the responsibility to be sure that he has an adequate supply when the time comes. The loss to the community of inadequate power is very serious in comparison to the cost of providing facilities. If he provides a little too much power, he is merely providing for the next year's growth and there is little in favor of inadequacy of facilities. There is, however, a favoring circumstance that these various contingencies of which I have spoken do not all occur at the same time. If it were not for that, the amount of reserves that would have to be provided would be very much greater.

There is another point I might make, and that is the distinction between the system planner who is looking ahead with everything before him and plenty of time to do the adequate thing and the practical operator who may be caught short through some misfortune and not have adequate capacity to carry his load. Should that time arrive, of course, he will use every means he can to provide the power. He will borrow from his neighbors, and if his condition is acute, he will try to borrow power from industry, and he will start up obsolete machines that have perhaps been given up. He will very often do such things as will enable him to give his service as best he can. But as I see it, the system planner is not forced by circumstances and he should not count on such expediences. If he is caught, all right, but he should

not count on them, and the use of these things in making his plans.

There is one other point which I would like to mention. This matter of reserve is after all a matter of insurance. There is no such thing as perfect service, as we all know. [fol. 1565] There have been some nationally noticed breakdowns in a number of important centers in the last two or three years. The systems do the best they can, but as long as absolute perfection cannot be secured, it is a matter of dollars and cents how much the expense will be that is incurred to reduce the failures. So after the allowance for the other matters required for reserves which I have used, I am free to say I think that is a reasonable total. If it is not a reasonable total, then I shift over and make allowances in the various categories until it seems to me the total allowance for reserve is a reasonable factor.

In this particular case I have taken for the machine reserve from one to one and one-half times the largest machine, a little different for different groups. I have taken 7½% of the forecast peak to cover variations of the nature of the cycle variations which I have described heretofore, and I have taken more or less 5%, representing transmission line outages and things of that sort, and the whole giving a total which seems to me to be reasonable considering the nature of the system.

From Defendants' Exhibit 133, the energy shortage in 1939, 770,900,000 kilowatt hours compares with 7,700,000,000 kilowatt hours which is the total forecast requirements for that year and is 10% of the total figure. The energy shortage of 2,169,500,000 kilowatt hours in 1943 compares with 9,966,000,000 kilowatt hours, the total forecast requirements in 1943, and is 22% of the total figure. The total capacity shortage in 1939 of 395,300 kilowatts compares with the total available capacity of 1,889,000 kilowatts and is 21% of that total figure. The capacity shortage in 1943 of 816,500 compares with the total available capacity of 2,373,000 kilowatts and is 34% of the total figure.

The document (offered and received in evidence as Defendants' Exhibit 134) is entitled "Details of Computations, [fol. 1566] Study of Load Forecast and Power Requirements of Four Groups of Utility Companies". In preparing the figures on Defendants' Exhibit 133, I had to go

through a considerable number of steps and computations and calculations which had to be based on some fundamental data. It so happened that the returns from the utilities made to the Federal Power Commission, of which I had spoken before, supplied sufficient detail for that purpose. For the ease of anybody who wished to check these figures, I have put down in this exhibit the intermediate steps between the original data and the conclusions. It is really a matter of convenience because it might not be so easy to follow them if there were not some guiding points. This exhibit is intended to give the details by which I arrived at the conclusions stated in Defendants' Exhibit 133. The information was taken from the same sources which I described in describing Defendants' Exhibit 133.

I have counted on the opportunity to state some assumptions that are made and the method of treating certain parts of this exhibit, because those are things which do not follow from an inspection of the table and without which it might be necessary to make a special investigation to find out what steps were taken on the part of anybody who wanted to understand it. I believe it would simplify the matter if I should put on record the particular matters I had in mind as complimenting and completing that statement which are not self-explanatory. In the beginning, I would like to state that it is known to those familiar with these studies of the question of shortage that there are a number of ways in which investigations may be made, some approximate and readily carried out and others more reliable but more extensive. I would like to say that I have used the most thorough and reliable method that I know for treating this question, and that it has been possible to do so on account of the completeness of the records which have been provided to the [fol. 1567] Federal Power Commission. The computation is based upon certain assumptions, that there should be no new construction of generating facilities in the region beyond those reported at the end of 1936 to the Federal Power Commission and that no contracts are considered as a firm source of energy except where there are non-cancellable contracts for firm energy. I point this out because there is a great deal of interchange of power in this region between companies, and very valuable and useful interchange, but it is interchanged because it is convenient for both parties to make the interchange. An examination of existing contracts shows that in very few instances have the utilities

committed themselves in a non-cancellable contract as far as the year 1943.

The studies are made for a certain year. It is customary to take such a period of time because that is the shortest period which repeats itself time after time. Of course, it is necessary to consider a very dry year in studying this question of adequacy of facilities. I have already stated that for the Electric Bond & Share group, I have used the year 1936 as the driest year for which I have the detailed information. 1931 is the year used for the other groups. In order to get the best and most accurate results, I have made the computations month by month, each month computed separately, and I have considered week days, Saturdays and Sundays separately, because the use of power on these different days follows different patterns. Furthermore, to take account of the variations of the use of power throughout the day and night, I have developed load curves for week days, Saturday and Sundays, the same curves for each month. In determining these monthly shortages, I have considered the amount of energy that the existing steam and other fuel plants of these companies can generate under these load curves, working in the base, as the expression goes. In making this determination, I have used 85% of the capacity of machines that are capable of normal operation [fol. 1568] omitting obsolete machines and those which are not used except in reserve. The 15% unused capacity is to take account of those machines which are under repair or which have been dropped out of service because of accident or otherwise. I have then considered the amount of capacity that can be handled by the machine capacity existing in the utilities' systems with the water available in the dry years, this water being used in the peak of the curves. The difference in the band between the steam and hydro generation then represents the energy that must be secured, and the width of this band indicates the generating capacity that must be furnished by the supplying company at the delivery of its transmission lines in order to deliver that energy as it must be used on the load of the purchasing company.

I would like to illustrate very briefly my last description since it is the basis of the computations. For that purpose I have prepared a chart shown as the last page of Defendants' Exhibit 134. It is a typical day load curve, by which I mean that this load curve indicates the delivery or use of

current on a typical day. The horizontal line at the bottom represents twenty-four hours a day and the figures beyond the figure 12 represent the time of day, the lefthand group representing the hours in the night and the righthand group the hours in the day time. Looking at the number 6 in the morning, half of the space on either side represents the section of the diagram set apart to represent six o'clock in the morning, or the hour between half past five and half past six. Follow the line vertically arising from the figure 6 until it strikes the heavy line, it will be shown what the demand was at that hour. The heavy line crosses the vertical line of which I speak on a horizontal line, and following that horizontal line to the left there is shown a figure, 30,000, and at six o'clock in the morning on this typical day the demand [fol. 1569] was 30,000 kilowatts. Similarly, on this heavy line all the way across the sheet, following up the vertical line from any hour, it is possible to find what the load was at that time. This gives a very wonderful method of expressing the variations in the use of power throughout the day.

Examination by the Court :

Saturday is different, because there are so many factories shut down on a Saturday afternoon and some do not open on Saturday at all. Under the present regime, there are a good many that work on a five-day week and that can be traced very clearly in the curve. I have taken holidays the same as Sundays. The detail of Defendants' Exhibit 134 shows that Sundays and holidays are referred to together. They are near enough alike in the use of power to be treated as though they were the same.

Direct examination continued :

There is one other very interesting and critical point. Referring to six o'clock in the morning again, if the power demand was 30,000 kilowatts for that hour, there were 30,000 kilowatt hours developed. That is what kilowatt hour means. It means a kilowatt for the duration of an hour. In the same way, for any one of these hours you can tell the number of kilowatt hours that were used. The total of those for the twenty-four hours gives the total of the kilowatt hours in the day, and also gives the area under that curve. We have divided the whole area up and the area

under the curve represents the kilowatt hours for the day, and that is where we get our mathematical relation and is what enables us to make these studies.

In this particular case, which was the typical daily load curve for the National Power & Light group for the month [fol. 1570] of October, which is the month of greatest shortage, the greatest capacity which was useful here, 85% of the available capacity of the steam machines, was 10,200 kilowatts, and that capacity can generate the amount of energy represented by the shaded line at the bottom of this curve. Those machines run twenty-four hours a day, and every hour they are developing 10,000 kilowatts. So it is very easy to determine how many kilowatt hours those steam machines can produce. In the same way, having found from the dry year of the past how much hydro energy can be developed in a day by the existing machines, I determined at the top of this curve how much of this area can be handled by that amount of hydro energy, and I draw the line and show the part of the load that would be carried by the hydro machines. The rest of the upper space is what must be provided from the outside, and the energy is equal to the area in that band. The capacity determined by reading on the lefthand scale, the difference in the height of the two lines at the top and the bottom will give the kilowatts that must be provided to supply the amount of energy that must be purchased.

The maximum consumption of electric power shown on the curve is at six P. M. and it is 70,000 kilowatts.

I should say a word about these forecasts. Of course, the amount of shortage depends upon forecasts, and it is important that they be made as accurate and as reliable as possible. The forecast must be made as a matter of judgment, and it is legitimate, necessary and proper to consider all the factors which are predictable in making a judgment as to what the total power requirements will be. I don't think it is profitable to go into detail as to how a man makes up his judgment in a matter of this kind, because it is a matter of instinct largely, but I will state how I arrived at my figures here. Turning to table C, the third table of De-[fol. 1571] fendants' Exhibit 134, it is shown how the forecast was made up. The forecast covers both the maximum demand, the peak and the energy in the third column from the end. The third column from the end and the last column give the figures respectively for maximum demand and

required energy, that is the prediction. The first three figures in each case are the figures furnished by the companies in their questionnaires. Beyond that are forecasts. This estimate was made by considering the probable rate of growth for the future as a percentage matter, but while the ordinary forecast is given as a uniform percentage, I wish to recognize the principle that these growths are rather by wavy lines than by straight lines, and I have arbitrarily given varying rates of growth stimulating this faster and slower development. Starting with the load of 1936, having assumed a percentage of growth, it is very easy to determine 1937, and so on. This is true both of the maximum demand and of the requirements. By that method I have arrived at the final figures which are shown on this sheet. It is a numerical operation. I calculate the per cent of growth and add it on. The same method was used for all except Kentucky Utilities, which made a forecast of their own and I used their forecast. The other companies did not make a forecast for those years.

The capacity shortage which I speak of is machine capacity shortage and not the energy shortage. I am referring to the underlying data for the first two columns in Defendants' Exhibit 133. I have gotten away from the forecasts now into a general statement. In listing the capacities for use in determining how much capacity can be carried by a given amount of hydro energy, I have summed up those hydro machines which have some pondage or reservoir capacity in such a way that they can be peaked, as the expression goes. By peaking I mean that the water can be stored for a considerable number of hours in the day at all times when it is not actually needed, and used quickly in a short period at the time of the peak load on the system so [fol. 1572] that a maximum value can be gotten out of the machine capacity at that station. I am referring now to the weekly period.

I have examined the forecasts of future load growth made upon the stand and represented by exhibits of Mr. Middlemiss, Mr. Rankin, and Mr. Moreland, and I have examined their exhibits, 372, 375, 501, 502, and 510, respectively.

The data given by complainants' witnesses as to forecasts of future load growths is by no means parallel to the subject matter of my studies. They have grouped the systems in this region in a different way, apparently, from the way I have grouped them. There are some cases in which the

figures are parallel and I have picked those out and will give very briefly the relations of those estimates and mine. These relate now to forecasts of demand. Mr. Moreland segregated all the systems within 100 miles of TVA dams, which is more or less the same group of companies as the companies I have considered,—by no means the same but somewhat similar territory,—so much so that a comparison of percentage growth might be of interest. Mr. Moreland's figures cover 1936 to 1943, giving a 40 per cent increase, and my figures for the same period give 46 per cent. The figures given by Mr. Middlemiss for the Commonwealth & Southern properties were 12 per cent increase for the period 1936 to 1939, 4 per cent a year. I have figures for the identical system which are 25 per cent increase for the three years,—practically double his. The 4 per cent growth for that particular region of the country for the three years seems to me to be a very pessimistic view of the region. Mr. Moreland segregated all of his groups for the same period from 1936 to 1939 and he showed a 21 per cent increase corresponding to my 25 per cent increase.

[fol. 1573] Cross-examination:

I am referring to the groups to which Mr. Moreland testified, his total maximum, all groups. I mean now all groups within the 250 mile area, as shown on Complainants' Exhibit 501. That is not the same zone which I am working on but I am giving it to you for what it is worth. Mr. Moreland gives for Commonwealth & Southern an increase of 12 per cent and my figure for the Commonwealth & Southern group was 25 per cent.

Direct examination continued:

Mr. Rankin, in considering the Electric Bond & Share group, those companies on both sides of the Mississippi River, gives an increase of energy between 1936 and 1939 of 28 per cent and my estimate was 24 per cent, which is less than his. Mr. Rankin's estimate of the demand for the same period for the same systems was 27 per cent and my estimate was 25 per cent, which is still less than his. Those are the only direct comparisons which I found could be made between my forecasts and theirs.

I am familiar, as far as required for making these studies, with the TVA transmission facilities and the location of the

generating plants, as well as with the transmission facilities and generating plants of the companies I have studied. In a region of this character where there are a large number of power plants scattered around and a considerable number of leading load centers, and where there is a network of interconnection and multiple lines between generating systems and load centers, the points of interconnection are very flexible. The electric current has a power of adapting itself to existing facilities, and power will flow, not where someone tells it to flow, but where it can accomplish the trip with the least resistance. In that, it is like water flowing in a series of channels, and it will divide itself [fol. 1574] up in such a way as to proceed with the least resistance. This means that if a series of interconnections are set up to supply various load centers for the future, and if the growth of the load does not turn out to be as anticipated, the current has the power of adapting itself to a considerable extent to the circumstances as they develop. On that account, I am willing to make suggestions as to where appropriate points of connection could be made with TVA with the understanding that if the time ever came to actually set up the installations, a review would have to be made of the circumstances to see if anything came up to change the decision. It is obvious, considering the Commonwealth & Southern, that Wilson Dam is one favorable point of interconnection. There is already, and has been for many years, a connection there to the Alabama Power Company system and vast quantities of energy have already been delivered from Wilson Dam to those companies. Another favorable point of interconnection of the Commonwealth & Southern, assuming the availability of power of these various dams, would be at Chattanooga. Other important points of connection with the Commonwealth & Southern Company would be at Norris Dam or Knoxville, and between Gunterville or that neighborhood, with some of the important circuits of the Alabama Power Company to the south.

A connection would naturally be made at Memphis with the Electric Bond & Share group of companies on both sides of the Mississippi River. A connection might be made at Norris Dam or Knoxville with the National Power & Light group, that is, the Carolina Power & Light Company and the Tennessee Public Service Company. A connection would naturally be made at the Pineville power plant or at some

transmission line center in that general neighborhood with the Kentucky Utilities. If it ever came to actually making [fol. 1575] the connections, the contracts involved under which connections would be made would have to be reviewed to see if any other conditions arose making it desirable to change the points of connection, because, as I say, they are flexible and considerable changes might be made.

There are very few potential customers of TVA power other than private utilities which could be feasibly served at the switchboard through transmission lines provided by the customers. There are a few of the larger cities and municipal plants in these cities that could build lines to the power houses. There are a few smaller municipalities and cooperatives, local industries and rural associations in the immediate neighborhood of the dams, that might be able to make connections, but I do not see that there would be any others. There might be a few large industries, especially at those dams, if they could find suitable places for the industries, sites which do not exist at most of them, and find labor conditions and transportation facilities.

As to what total classes of customers could feasibly reach the dams if TVA did not provide transmission lines, except for those in the immediate vicinity of the TVA dams where the transmission function is not a serious matter, it would only be the larger consumers who might be either private or municipally owned, and who are within such a range that private lines could be reasonably built, warranted by the benefits. The problem of the most feasible method for TVA to serve small municipalities, industrials and rural co-operatives in the general region of the Tennessee River is not particularly different from the problem arising in municipalities of serving scattered minor customers, and it is accomplished and would be accomplished here by networks [fol. 1576] of transmission lines which are laid out to different sections of the network to serve several customers. Where larger demands appear locally, a small increment in the capacity of the lines can be added at small cost. This method of distribution is far more feasible than the building of individual lines for the service of individual small customers.

“By Mr. Fly:

Q. Mr. Thomas, assuming that the construction and operation of Norris Dam or other dams on the tributaries of

the Tennessee would make available a substantial amount of additional continuous power at Wilson Dam, in your opinion would this increase of the firm power at Wilson Dam be a useful and valuable asset for national defense purposes, in connection with the Muscle Shoals properties?

Mr. R. T. Jackson: I object to that question, object to the competency of the witness to answer; also object to it as irrelevant and immaterial."

Thereupon the witness testified by way of further qualification as follows:

During the war, I was consultant to Mr. Frederick Darlington, Chief of the Section of Power of the War Industries Board in matters concerning transmission and interconnection of power. As a member of the Federal Power Commission one of our duties has been to assist in the national defense and study the problems of interconnection. I was with the War Industries Board about 1917 but have not been connected with the Army staff since then. I do know that the Army Engineers are studying the possibilities of concentration of power for war purposes in case the need comes, but it is not my understanding that they have jurisdiction in that field. The Federal Power Commission is also considering the availability of power from utilities in time of war.

"Mr. R. T. Jackson: I renew my objection and I also want to point out that, notwithstanding the statement of this witness, to the best of my knowledge and belief there is nothing in the Federal Power Act that gives the Federal Power Commission any function with reference to national defense.

Judge Allen: The objection is sustained to the form of the question as originally asked.

[fol. 1576-a] By Mr. Fly:

Q. Mr. Thomas, assuming that the tributary dams of the Tennessee Valley Authority will increase the stream flow, and hence substantially increase the—say, the tributary dams and the other dams upstream will substantially increase the stream flow, and will substantially increase the firm power at Wilson Dam, in your opinion would that increase of firm power, increase the value of Wilson Dam?

Mr. R. T. Jackson: Just a moment. Increase the value of Wilson Dam for what purpose? Power purposes? If it is for power purposes, I object.

Judge Allen: Do you object to the question as put?

Mr. R. T. Jackson: No, I don't object to it as put.

A. It will, since it will permit the delivery of larger amounts of power from that station."

In my opinion the interconnection of the various power plants of the Authority with Wilson Dam will increase the value of Wilson Dam.

Summarizing my conclusions as to the available market for the Authority's power, if the Authority's sales were limited to the dam sites I conclude that if the private utilities be not included, the sales at the dam sites would be very limited—only those exceptional customers to whom I have already referred.

[fol. 1577] Cross-examination:

Referring to Defendants' Exhibit 134, Table A on Sheet 1 for the Commonwealth & Southern group, I did not use any figures for installed hydro and installed steam capacity on those tables. I do not know that I have the installed figures. They don't mean anything in a study of this kind. I have had these figures before me, but they are not in this exhibit. I might be able to hunt those figures if you give me time enough, but I haven't them in this exhibit. The installed steam capacity doesn't mean anything in this study. I think I have in my work papers the figures for the installed steam capacity for the Commonwealth & Southern group if you want me to look for them. I have a figure here of 455,500 which I believe is installed capacity for the Commonwealth & Southern group. There is always a question there as to just what to include in that total. That is the steam capacity. I think it includes oil engine capacity, the fuel capacity. There is a very slight difference in the Commonwealth & Southern group in that. I have a figure here of 867,700, which I believe is the figure of the installed hydro capacity for the Commonwealth & Southern group. The installed capacity of the fuel plants of the Electric Bond & Share group is 201,900, as I have it here. Those are figures which I have not used in my studies, but I presume they are the figures off the questionnaire. The installed hydro capacity

of that group is 65,700. The corresponding figures for the National Power & Light group are 16,000 kilowatts for the fuel plants and 113,700 for the hydro.

For the Kentucky Utilities group the installed capacity of the fuel plants is 42,500 and there is no hydro capacity, as I have taken the Kentucky Utilities. The Kentucky Utilities is a fairly extensive system. It has a section centering [fol. 1578] around Pineville and a section centering around Dix Dam, Lexington, connecting into Louisville. The interconnection is a 66 kv. line, rather limited capacity, and I have not considered that line of sufficient capacity to permit the pooling of power, so I have assumed in my study that only that portion of the Kentucky Utilities which lies south of that 66 kv. line should be included, and that portion has no hydro. I excluded all of the Kentucky Utilities system except the Pineville system in my estimate, except that I have assumed, I believe it has 4,000 kilowatts of reserve capacity which would be counted on by the Pineville section from Dix Dam over that line. They do have a hydro plant at Dix Dam and a dam on the Ohio River is interconnected with the Kentucky Utilities and the two hydro plants are operated together, if together means one helps the other. As to why they built the 66 kv. line if it was no use, I did not say that the connection was of no use. I merely said that I did not think it was of sufficient importance so that it could properly be said that the region to the north was operated with the region to the south as a unitary group. There is a mere interchange over that line, but it is a mutual agreement from day to day as they may find it convenient to swap hydro power going south and steam power going north. As to whether they use that line and the interconnection of the steam and hydro to give them additional firm power, they interchange to save cost. There is no evidence in our reports of any firm obligation one way or the other. In fact it is a single ownership, so that could hardly be expected. It is not my point of view that because I saw nothing which I thought was a firm contract in that report to the Federal Power Commission, I disregarded any interconnection and the fact that the systems are actually operated on a coordinated basis. My point of view was on this that I am acting as a system planner and am in charge at Pine-[fol. 1579] ville in that region and I am looking forward to increased loads and what provision I must make in order to satisfy my maximum demand. I am familiar with these

facilities to the north, I know they are going to have demands for more power, and I am sure, looking ahead, that by the time I am short of power they will be short of power too, and I will not get any power from them unless I have a firm contract which is non-cancellable, and no such contract exists. Therefore, I have assumed that the power they might hope to get from there is in the list of power to be obtained. If they obtain it all right, that is one way for them to supply the shortage. As to whether it is a fact that that line was built for 110 kv., I believe it is built in such a way that it can be changed over to 110 kilovolts. It is not operated at 110 kilovolts.

Assuming the system planner had made arrangements for integrated operations, as to whether I nevertheless disallowed that because if I had been system planner I would have done something else, my point of view is really quite different from yours. If I were the man responsible for full operation of that system, I would look it over and see where was the best place to get power for the growth of each half, and if the northern half were overloaded, I might well find that power could be gotten for the southern half by buying power from the TVA or building a station down there or something of that sort. In any case I would not feel justified in 1937 and 1938 in not providing for any portion of the load I saw ahead, on the theory I might be able to take some power away from the northern section when they did not have any to spare. As to whether I knew they did not have any to spare, I am looking forward to the time when they are going to have a load growth, and nobody knows whether they will then have anything to spare. I daresay they have some to spare now. I have not investigated that. I eliminated it as I am not considering the present time.

To get the load from the Pineville District, I examined the operating records and found that the interchange of power over this 66 kv. line had some peculiar relations. That line has a more or less limited capacity, and, knowing the voltage and size of wire, I can tell somewhere near the interchange which can take place. I found that in times of low water at Dix Dam there was a considerable export of power to the North, and in times of plentiful water there was an export of power the other way. At any rate, the generation at Pineville was high at the time of low water and low at the time of high water. I made the assumption

that the true load in the Pineville District was between the two, and that when water was scarce in the north, the generator at Pineville, in addition to carrying its own load, would send power to help out Dix Dam, and at times when there was a plentiful supply of water, that the Pineville machines were not carrying all their own load, they had a little help from the water plant. That was the basis on which I determined the load in the Pineville District. I did not take my assumptions from any report to the Federal Power Commission. They did not give it. I did not discuss the integrated operation with the operating men who handled these companies. These statements that I have made are based upon the physical characteristics of the systems and the operations in the past. I did know as a matter of fact that the Kentucky Utilities sells some 2500 kilowatts of firm power to The Tennessee Electric Power Company. That is the contract demand which they sell. I am looking to the future and not the present.

Referring to the first table A, Defendants' Exhibit 134, by capability of steam plants I mean that when a utility contracts for a certain output and when the generator, steam or hydro, is put into operation and is perhaps set up in conditions slightly different from what the manufacturers expected, and they do not find it performs exactly the way that it was anticipated, or if the manufacturer has been a little liberal, they can get more power out of that machine than was promised. Having established the fact that the machine can, as installed, give more or less power than is shown on the nameplate rating, which is the manufacturer's promise you may say, and which has been reported by the utilities to the Federal Power Commission, I take the revised figures which I call the capability. I said the installed capacity was 455,500 and my figure in my exhibit, "Capability of steam plants, 398,700 KW." is for that group of plants which are capable of normal, regular operation. Looking on that chart, further down, there is shown the customer plants and reserve only. If those are added to the 398,000, the total is substantially the same as the total figure of 455,500 which I have given. The 398,700 capacity figure is the sum of the capacities of a number of machines which I selected from the total lists of the reports of the Commonwealth & Southern to the Federal Power Commission, the balance of the machines being grouped in this item below, at 51,500 kw. The two together give the total,

but I arbitrarily separated it into two groups. The reason that I eliminated 51,500 kilowatts in the latter group was this: my explanation of the typical load growth was by giving them a 24 hour load in the base. This figure which I have here is related to the total capacity of the machines, which I assume can be used in that manner, and those machines listed in the 51,500 kw. group are not machines which would be so used. They are machines in customer plants and other places which are not kept in regular service, though they might be put into service. I have separated them into two groups solely to have a figure to take 85 per cent of in order to secure my shortage figures, as I have described the method before. It is not a matter of setting [fol. 1582] aside certain steam plants as reserve capacity and I did not eliminate some of the steam plants entirely. I think perhaps some of them should be eliminated, but I have assumed that there might be contingencies in which it might be worth while to rehabilitate them. I did not eliminate any one of the steam plants.

As to whether in determining the capability of the steam plants I assumed limitations due to high temperature of circulating water, I merely took the ultimate figure that the companies have reported, without reporting in my exhibit here what the reason was. Of course, I would note the reason in my own mind, but it was not necessary to put it in here. I took the net figure which the company gives as capability. It is my testimony that this is a figure which I took off a company report and not an estimate of my own.

In dealing with Group 1 on Defendants' Exhibit 134, as stated in the heading, I have taken only the hydro plants having some pondage. This is a determination of the capacity at the minimum water flow of a very dry year. There is so little water that unless it can be stored in a pond or reservoir to be used on the peak days, it is of very little value. I am establishing here a figure of machine capacity, so as to see if you have got a certain amount of water which is applied in the load curve that I have shown, and takes care of a certain amount of capacity. I am establishing this figure to be sure that there is enough machine capacity in these plants to be able to carry it, so if a machine is on a river that does not have a pond it is of very little value. There are two sorts of elimination here. I have eliminated the Nacoochee plant of the Georgia Power Company and Langdale, North Highlands, Flint River, High Falls, Bar-

nett Shoals and certain small miscellaneous plants, eight plants aggregating about 8,000 kilowatts. I do not have the names of the smaller plants aggregating about 8,000 kilowatts. That is not all the eliminations I have made. In [fol. 1583] addition, considering the Alabama Power Company plants and the Georgia Power Company plants as a whole, I have discounted the total capacity obtained by adding up those plants I have not eliminated, because those plants being on the same river and the same pondage water having to pass through them all, it would not be possible to get a 100 per cent value of all the capacity for all the plants. The elimination figure was 10 per cent in the Alabama Power Company plants and 15 per cent in the Georgia Power Company plants. In other words, after eliminating about 30,000 kilowatts of normal capacity of the smaller plants without storage, I have discounted the Alabama Power Company by 10 per cent and the Georgia Power Company by 15 per cent. In The Tennessee Electric Power Company I eliminated one or two plants. Ocoee No. 2 was eliminated, Hales Bar, and eight miscellaneous plants aggregating 3,700 kilowatts were eliminated. I eliminated the entire plants.

I am not in agreement that it is a fact that the pondage on all of the plants of the Alabama Power Company in Alabama and the Georgia Power Company in Georgia is large enough to be operated at 100 per cent efficiency. I would like to point out that for one thing the Jordan Dam has a limitation in that certain water must be passed for navigation purposes on the Alabama River and that the Thurlow plant has very limited pondage. Further than that, I would like to point out the principle involved, which is that when a generator operating in a plant with pondage passes water to generate power for peaking purposes, this water is discharged always at 6:00 o'clock in the evening, if we refer to the typical load chart for the time of maximum demand. That water then has to pass down to the next plant, and if it is to be used to produce power in that second plant, it must arrive there at 6:00 o'clock to do any good, and that is either 6:00 o'clock the same day or the next day. These [fol. 1584] plants are placed at odd intervals along the river and in most cases the water which passes at a certain time in one plant has some lag before it is found in another. I understand that it is possible by skilful manipulation to pass the water from the pond perhaps early in the peak, or two

or three hours before the peak in the upper plant, and if the second plant happens to be close enough so that the water gets there before the end of the peak, perhaps three hours later, it might be useful. In general it is not possible to use the same water in all the plants on the peak and it is in an effort to appraise that limitation that I have made this percentage change. I am free to state that it is a matter of judgment and that is my judgment. I have given the matter a good deal of thought and have looked over and studied the physical set-up of the plants as far as it is available, and I believe those are fair figures, and I have very grave doubts if any organization can operate those plants to do as well as that in the actual case.

As to whether I have given my testimony that the pondage of the Alabama hydro plants is not sufficient to hold the water released from the upper plant to the next plant until the peak of the following day, the point that I made was that when the water was once released from one plant, it is started on a journey, and it is beyond the control of the company and they cannot have that water appear at another plant at the time they want it, when the demand is great. As to why they can not hold it at the next plant downstream if the pondage is large enough, if it don't get there when needed it will not be there. It would be possible to hold the water at the next plant down stream, if the plant had sufficient pondage to close the pool for a week, but this is not the case. As to whether I know it to be a fact that the men who have operated these plants have succeeded in operating them so as to utilize that water at each [fol. 1585] plant downstream at the peak, they have never yet operated in that way. I am considering the period of time from 1939 to 1943 and until that time I cannot tell what will be done. As to whether I know that the men who operate those plants have succeeded in operating them in that way, I have just told you that the test has not yet come. As to whether the men who operate these plants have succeeded in operating them in the past so as to utilize all the water at each of the successive plants of the company, I am not familiar with the detail of the daily operation. I cannot answer the question without consulting the day to day record. I have not studied the log sheets of operations of the different plants. It might or it might not be true

that the log sheets of the operations and the actual experiences of the men who operate these plants would be better than an estimate by someone else for 1939. I am somewhat familiar with the way these things operate and the customs among operators and I have just got to give the best impressions I have.

I have included all the energy in the dry years and I have added to it in the case of most companies a percentage to cover all the additional power which might be used if they had a larger load, 10 per cent in 1939 and 25 per cent in 1943, over and above what they actually used, on the theory that in a dry year a little water is wasted and with larger loads than I have forecasted, they could use a little more, and I have added that to the available supply.

I know it to be a fact that the machine capacity of Ocoee No. 2 is 18,000 kilowatts. I have no knowledge that it is a fact that the firm capacity of Ocoee No. 2 is 18,000 kilowatts in an extreme low water year. I know that there is a large pondage or reservoir in the next plant above Ocoee No. 2. I do not know whether that plant is operated so as to make the firm power capacity of Ocoee No. 2 18,000 kilowatts. I have not considered the present operation. I have considered [fol. 1586] the most favorable operation that could be handled in 1939 and 1943. As to whether I think the pond up above will be destroyed in 1939 and 1943, I have explained that the water cannot be used in both plants at the same time. The point is, it is good for either plant, but not for both. I am not familiar with the fact that when water is released from Ocoee No. 1 on the peak on one day, it gets to Ocoee No. 2 the next day on the peak. I did not include that in this computation that I gave.

I have no figures to show that the firm capacity of the Hales Bar Dam is 25,000 kilowatts and I did not include it in the pondage plants. I did not throw out the energy there, but I did not include it among the plants which I said had pondage. For the purpose of load carrying capacity, I threw it out for the peak capacity. My energy figure is the figure for the year. The other figure is the capacity at the peak of the load and there is no relation between the two. I did not understand that a computation of all the energy for the year without regard to and discarding its production at the time of peak during low water is a wholly

unrelated thing. There is a minimum generation on the peak in this company's hydro plants which I have not included in the pondage. There is a minimum flow of energy there which cannot be accumulated to be used suddenly on the peak, but it is in the average run of the river. I assume that whatever capacity is taken care of in 95 per cent of the figure I have, is too small a volume to attempt to break up into numerical values. I have recognized its existence, but it is immaterial in amount.

I did not eliminate any hydro plants in the second group, except that there is one plant, Russellville, I think it is, with 700 kilowatts capacity which was not included as a pondage plant. That is in Group No. 2, the Electric Bond & Share Company property on both sides of the Mississippi River, and that is the only plant in that group. In the group known as the National Power & Light, I have eliminated [fol. 1587] Marshall with 3,000 kilowatts owned by the Carolina Power & Light Company. I have included the Carolina Power & Light, Western Division, but gave no attention to the Eastern Division of the Carolina Power & Light so far as generating capacity is concerned. My set-up is that the Western Division is an isolated division, isolated from the Eastern and Southern divisions. There is an interconnection between the two, they have contracts, and that relation is carried out through their contracts as though the two were connected for general operation. As to the size of the interconnecting line, it is not an interconnecting transmission line between the two, but it is a swap of power. The Carolina Power & Light Company has a contract by which it delivers power from the Western Division to the Duke Power Company at Greenville, South Carolina. At the same time the Duke Power Company agrees to deliver power to the Carolina Power & Light, Southern Division, at Wateree. Further than that, they have a practice which I believe is covered by contract to some extent at any rate, by which the Appalachian Electric Power Company will supply or deliver some power from the Carolina Power & Light through the Kingsport connection and will deliver power through, across the Virginia line to the Eastern Division of the Carolina Power & Light. It is rather limited in quantity, but it is an operation by which there is a swap of power, and the result is that power generated in the Western Division is used in the Eastern Division.

After I graduated from M. I. T., I spent some ten years with the Westinghouse Company. That was a manufacturing company. In those days the manufacturing companies had almost a monopoly in the knowledge and had to furnish most of the technical information for the operating companies. At that time they were not engaged in making mercury lamps. The mercury lamps followed by about ten [fol. 1588] years my connection with the Westinghouse Company. During the first ten years, I was studying static conditions with reference to high tension transmission lines. As to what voltages and what lengths of line I was studying, I have in mind not the complete design of these transmission lines but the methods of operation. Of course, there were a great many lines involved. I was familiar with everything going on in the country so far as that goes. The voltages involved at that time I think ran up to 110 kv., but I don't want to be held very closely to that. It was a gradual evolution. It is a fact that power today is being transmitted in this country at voltages up to 287,000 volts and over distances of over 300 miles. There is one pair of lines of high voltage of that amount and slightly less than 300 miles.

I was also chief electrician of the Cooper-Hewitt Company, which was a manufacturing and research company. After that period as a consulting engineer, I was with the interests of Guggenheim Brothers, but not at their plants in South America. I was connected with them a little less than ten years. They were engaged in very extensive mining operations in South America. The principal part of that work was mining. I did some work for utilities at that time. We prepared plans for certain plants for the City of Santiago, Chile. I was not an engineer with the City in connection with the construction of the hydro plants but my department with the Guggenheim Brothers was given the commission of doing this design work. I might add that the operations of the Guggenheim Brothers in mining was practically utility operations. They had to maintain villages for their employees, transmission lines, water, sewerage and other utilities. That is, they had villages at their mines up to about 5,000 inhabitants. I would regard the Guggenheims as engaged chiefly in engineering and mining operations.

[fol. 1589] I was in this country as a consultant from about 1923 to 1934, and after that I went on the staff of the Federal Power Commission. I was consulting engineer with the Guggenheim Brothers in charge of power operations. I was in charge of that division in the way of designing and supervision of operations, but not in charge of personnel or direct operations, but in charge of the supervision of purchasing, so far as engineers handling the supplies is concerned.

Examination by the Court:

As to what I did with the Guggenheims, I was consulting engineer in charge of power operations. I was in charge of that division in the way of designing and as supervising of operations, but not in charge of personnel or direct operations, but in charge of the supervision of purchasing so far as engineers handling the supplies is concerned.

Cross-examination continued:

I have never had responsible charge of the operation of any public utility system in this country. I have never been general manager of a utility, if that is what you mean. I have never had the responsibility for the actual operation of any large utility system in this country. In my work with the Federal Power Commission, I am engaged chiefly in work of a statistical nature and have no direct contact with the operation of any large utility system. As to whether in my work with the Federal Power Commission I was chiefly engaged in work of a statistical nature and had no direct contact with or responsibility for the operation of any large utility system, I have no more authority than the Federal Power Commission has and it does not have charge of operation and supervision. I do not have actual charge of the operations of any large utility system. I am appearing in this case in my private capacity and not as an employee of the Federal Power Commission. As [fol. 1590] to whether I am employed by TVA, my time has been assigned to them. I have made no change in my relations with the Federal Power Commission, but there is some arrangement between the TVA and the Federal Power Commission as to the time.

I used reports made by public utilities to the Federal Power Commission as the basis for my estimates. As to

whether it is a fact that these reports or answers to questionnaires submitted to the Federal Power Commission by public utilities are confidential, I think the Federal Power Commission has authority to use them. They have used them in the past. I do not know that they are confidential. I don't know that they are not. I don't know what you mean by confidential. As to whether it is a fact that the answers to the questionnaires are not open to the public, they have been used many times and are open to proper persons. I don't want to pass on the law of the matter, that a good many of these records are by law open to the public. As to whether it is my testimony that anyone may go to the Federal Power Commission and inspect those records or take copies of them, the Federal Power Commission has given certified copies of these records and reports a number of times. We did not give photostats of these records and reports to the TVA; they got them from us. They didn't take them away from us. I have no information that the Federal Power Commission refuses access to private engineers or engineers representing public utilities as far as these questionnaires are concerned. If I wish to show them to somebody, I ask permission from the Commission and I don't take the responsibility personally.

The first line on the first Table A of Defendants' Exhibit 134 shows the maximum annual demand and the underlying data for that table is found on Table C. In Table C, I show in the second column from the left the annual rate of increase assumed. The figures for the years 1934 to 1936 are actual and from there on they are estimates. For the year [fol. 1591] 1937, I show a figure of 9.8 per cent. As to whether it is a fact that actually the demand in 1937, instead of increasing 9.8%, has decreased 9%, I have no figures on the demand for these companies. I am not surprised to hear that the increase is less than this 9.8% on account of the slump that has occurred in these last few months. I would be very much surprised to hear that if the figure for the year 1937 was made to accord with the fact, it would show a minus 9% instead of a plus 9.8%, but it may be so. As to whether I investigated that, I do not have the figures available.

Going down the second column from the left on Exhibit C on Sheet 3 of Defendants' Exhibit 134, there is shown a figure of 5% in 1939, 3% in 1942 and 8% in 1943. Those

figures represent my estimates of variation in the total conditions. Those variations were put there to recognize the fact that these growths do not occur in smooth, straight lines. The growth of plants and the growth of loads do not come in uniform percentages, and to recognize that fact I have arbitrarily shown varying percentages for different years. I made the statement that I did not expect that the variations would hit the right years, but the average throughout the period I have taken would be a reasonable average, and it could not be criticized because I had assumed a uniform rate of growth when everybody knows that is not the way the load grows. I had no more reason for putting 3% in 1942 and 8% in 1943 than I had for putting 8% in 1942 and 3% in 1943, and I had no reason for selecting those two years. The figures for 1939 and 1943 on sheet 1 of Table A of Defendants' Exhibit 134 are copied from Table C. When I assumed the maximum annual demand for those years, I used the best judgment I had in the light of all the facts that I had. The 9% decrease for the year 1937 will be made up by 1939. I have taken my [fol. 1592] 1939 and 1943 estimates as shown on Table C and in the second line of Table A, sheet 1, I have added to that 7½% more. After making the best estimate I could for 1939 and 1943, it is not right to say that I have increased those estimates by 7½% of the estimate that I had previously made. What I have predicted here on the first line is what I think will be the annual trend of the demand. I pointed out that there are variations up and down which do not affect the trend but which do have to be provided for, and I have also explained that it is necessary to build a little ahead to have capacity on hand until the next period of planning. Further than that, you cannot buy machines to exactly fit the load, but a machine a little larger is bought because it is generally more economical. Those items are calculated in that 7½%, which I have explained at considerable length. In the second line of sheet 1, Table A, I have added 7½% of the figures shown on the first line as part of my reserve, and I then took that figure as the maximum condition for which capacity must be provided. In that sense it is correct to say that I have added 7½% of my estimate.

In my figures in these tables, I have made no allowance for installation which was not included in the reports for

1936. In this first group, the Commonwealth & Southern group, it has been testified that there is now on order turbines with a capacity of 105,000 kilowatts which are now being manufactured. I have made no allowance for that in this table.

It takes from one to two years to install additional capacity. It is common sense that proper utility management contemplates and requires that a utility shall provide enough capacity to take care of its actual and potential demands in the period of time during which new facilities can be added, and it is a matter of judgment whether a utility should build facilities far in advance of its probable or likely needs.

[fol. 1593] "Q. Well, Mr. Thomas, if a utility builds facilities far in advance of what may be needed or will be needed within the period during which new facilities may be constructed if desired, is the expense of those unnecessary facilities borne by the utilities, or the consumers?"

A. No unnecessary—no disadvantageous building ahead should be undertaken, of course, it should be done only when there is an advantage in it."

It is not, broadly speaking, true that proper and prudent management of the utility would require that the utility should provide facilities adequate to meet requirements during the period that would be needed to install adequate facilities. If it can be shown that there is an advantage, a saving in any form in building ahead, they should be built. If they could get a bargain and could buy a plant very cheaply, which they would have to pay twice as much for, built later, they should buy.

"Q. But aside from that, Mr. Thomas, prudent management should indicate that you should not build greatly in advance of the public needs, unless it was necessary as a matter of prudent construction?"

A. I think I have explained my view there."

I started with making my estimates shown on Defendants' Exhibit 133 for shortages for the year 1943 very early in the fall of 1937. I would not think that it would be necessary or good utility planning and operation to require that a utility should have in 1937 facilities sufficient to serve the predicted demand six years later, in 1943. A utility would

be very greatly overbuilt for a temporary period if it were to construct facilities in 1937 to meet a demand estimated in 1943 and provide for approximately 35% reserve and provide for 7½% extra demand for contingencies.

"Q. The Federal Power Commission would not approve the inclusion of the cost of such excessive capacity as a prudent investment in a rate base, would it?

[fol. 1594] Mr. Fly: I object to any such legal conclusion as that, as to what the Federal Power Commission might do by way of formal action.

Mr. R. T. Jackson: He is trying to indicate what the facilities should be.

Judge Allen: Objection sustained.

Mr. R. T. Jackson: May we have our exception, please.

Judge Allen: You may have it."

All that Defendants' Exhibit 133 shows with reference to 1943 is that if my estimates of load curve were correct, and if it were proper to have such a large reserve capacity as I have suggested, and if all of these hydro plants could be discarded and ignored, as I stated yesterday, and if these utilities built no additional facilities in the next six years, there would be, in my opinion, a shortage of capacity of the order or magnitude shown on my exhibit. I would not expect to find today any utility, if it were prudently managed, with facilities that would meet those requirements for 1943, unless there were some very special conditions.

Referring to the figures for the Electric Bond & Share group on sheet 8, Table A, on Defendants' Exhibit 134, in the first line there is shown for the starting figure in 1936 a maximum annual demand of 225,800 kw. That is supposed to be an actual figure.

"Q. According to my information, and the records of the company, that is not in accord with the actual figure for 1935?

Mr. Fitts: We object to the form of the question.

Judge Allen: Objection sustained.

Mr. R. T. Jackson: May I have an exception. I have not yet completed my question.

Judge Allen: You may have your exception. Ask the witness a question. Mr. Jackson, if testimony is presented to [fol. 1595] that effect, then you can incorporate it in your

question, but the Court cannot consider statements of counsel as included in your statement.

Mr. R. T. Jackson: Of course, I just wanted to direct the attention of the witness to what the situation was, and ask if he knew the explanation.

Judge Allen: Stated in that way the question is objectionable, and the objection is sustained.

Mr. R. T. Jackson: Of course, we take our exception.

Judge Allen: If you want to ask the witness whether that is a fact, ask him."

I think I shall have to make a slight correction in the last answer. That figure of 225,800 kw. is the reported loads reduced slightly by the figure of diversification. The sum of the different company loads would be 240,300 kw. which is explained on Table C. It would not be quite fair to add all the totals of those companies up and not make any allowance for diversity of the peaks, and the difference of 240,000 and 225,800 is the allowance that I made as described on that table. I do not recall having made any allowance for isolated sales where it happens that the company has certain properties that are not interconnected, as this is intended to be interconnected companies. I am not very clear, it is just possible that there might have been some small properties that are not included in this. I cannot remember whether I took out of the figures sales from non-interconnected or isolated properties. It was a very small amount, if any. These figures are for interconnected sales which the company reported. There were no sales actually taken out and I have no recollection that there were any in.

On this Electric Bond & Share group, the capacity of the fuel plants of 205,000 kilowatts is the sum total of the figures given by the companies, the capabilities of the plants. I did not eliminate any steam plants. I did not include 12,000 kilowatts steam capacity added in this group during 1937.

[fol. 1596] "Q. Did you make any allowance for any interconnection with other companies, such as the New Orleans Public Service Company?

A. I examined the inter-connection contracts covering them to see if there were any non-cancellable contracts. While a number of contracts between the companies are cancellable on short notice, and as I explained, I did not consider that as satisfactory for 1939 or 1943, as an elimination of their provision for capacity.

Q. You did not make any allowance, is all I asked?

A. No, I did not make any allowance."

I am not sure whether I made any allowance for capacity available at the customers' plants. I used what the company gave here.

I have not made the comparison and do not know whether the diversified demand or peak shown on page 10 of Defendants' Exhibit 134 exceeds the actual demand shown in Complainants' Exhibits for this group. If the diversified demand or peak for 1936 does exceed the actual diversified demand or peak, that error would persist in the same percentage up through 1939 and 1943. It would not be multiplied. If it was an error by being too large, the percentage of error would remain the same, but the total kilowatt hours would be increased.

With reference to the Carolina group, the second of the Electric Bond & Share groups, I have excluded the Southern and Eastern sections, but I do not know that that excludes all of the Carolina Power & Light system lying east of Asheville. It would be east of Asheville. The Duke Power Company comes in between the two sections. I stated that the Southern and Eastern sections are actually closely integrated with interconnections with the Duke Power Company and the Appalachian Power Company. I am familiar with the situation that the Appalachian Power Company gives [fol. 1597] the Carolina Power & Light Company the privilege of transferring energy through the Appalachian system in any direction and at any time, and that large amounts of energy are so transferred, but I am not sure that that is an accurate description of that situation. I know they do make transfers and I have here figures which show that 9,500,000 kilowatt hours net were transferred to the east in 1936, which is found on Table B. It would be a very exaggerated statement to say that there is full coordination of the predominantly steam Appalachian Company and the predominantly hydro Carolina Power & Light Company. There is a long high voltage line interconnecting Waterville, the principal station on the western division of Carolina Power & Light, with some of the large stations of the Appalachian Electric Power Company. It is a long, circuitous route, and energy is passed and can be passed over it. It is a very important line, and it is very well known among engineers, but it does not constitute, to my mind, close coordination of

these two systems. The gross amount which was passed was about 12,000,000 kilowatts eastward, and about 3,000,000 return in 1936 over the Duke connection. It is true that there is coordination carried out by the Carolina Company supplying hydro energy to the Appalachian Company whenever available, both during peak and off peak periods, and the Appalachian Company returning this energy at off-peak periods during the Carolina's dry season. I did not eliminate the Kingsport-Waterville line, but after studying that situation, I came to the conclusion that there was no non-cancellable relations by which, if Appalachian was short of power in 1943 and Carolina Power in its western division was too, that the Carolina Company could coerce the Appalachian Company to give them power they could not spare. There was no such relation there, and so I did [fol. 1598] not count it in the dependable capacity of the western division of the Carolina Power & Light. That line is freely used now in the practical operations of the company and there is plenty of power there now and they save some money by it. When I spoke about the exchange of power of 12,000,000 and 3,000,000 kilowatt hours, I was talking about the interconnection through the Duke Power Company. The exchange with the Duke Power Company is this: The Waterville station, or the network there, supplies power to Greenville, South Carolina, and it can be used by the Duke Company to advantage in its local work. To compensate, they supply from Wateree far to the east, which is a station on the Catawba River, where they have capacity, to the Southern Division a good many miles away, of the Carolina Power & Light where they need a little support.

I have not given the figures for transfer from the Appalachian, but I might be able to dig them up. I do not have those figures in my head, but I have been over them and looked at them. It is a sensible amount, but it is a small figure in money value though a large figure in kilowatt hours. It is dump energy.

I testified about various points at which interconnections could be made between TVA plants and utilities. I have no definite knowledge that all of these TVA power plants are to be interconnected with high tension transmission lines except what I read in the newspapers. I don't believe I am competent to answer that.

"Mr. Fly: We will concede that point."

I assumed that there would be a reasonable amount of interconnection between the various TVA plants and some exists already. I said that these were very elastic and that the power might flow one way or the other, depending upon conditions, and I understood that there were to be transmission lines connecting up all these systems, but of course [fol. 1599] there are a number of other lines existing in that neighborhood which I had partly in mind. My testimony as to the various points of interconnection which I regarded as feasible was not based upon any studies of pooling that I had made. They are matters of common sense. I am pretty familiar with that region and have studied it for a good many years. It is obvious to any engineer that with the location of power where it is, and the load centers and existing lines where they are, that those would be obvious points of interconnection. I have not made any final study of the best way to do it or the capacity or anything like that. As to whether I made studies of pooling of TVA power and the power of utilities, that is a broad term. Studies of pooling might mean anything. I made a good many studies of the possibilities there, but I would not want to be too specific in defining just what they were. As to whether I did or did not study the possibilities of pooling, as I say, it is a broad term. Pooling might be two particular plants combining their output, or it might mean six or eight states combining their forces. As to whether I did study the pooling of the TVA proposed system and the existing utility system, well, I have certainly, in a general sense. And this study is bearing upon possible pooling. I do not remember that I was the author of any paper advocating pooling of TVA power with the other utilities. I do not know what you mean by paper. I do not know what you have in mind, but perhaps I have said something somewhere, if you can tell me what.

I have made a number of studies but none were directed at the principal object of whether the most economical production of power would result from pooling of any proposed TVA power system and the systems of the utilities, so I cannot give a definite answer as to the advantage.

[fol. 1600] "Q. You cannot? Well, assuming that TVA had the right to generate power, and assuming that it could be sold at advantageous prices, would not sale to the utilities for distribution over existing lines with no additional cost paid for the current to TVA bring about the most wide-

spread public benefits, if any, of such generation and sale of such power?

Mr. Fly: I object to that question on the same grounds as heretofore. That is not only entirely irrelevant, but it is an effort to open up here in a conclusory way and by one or two questions a series of transactions that would have to be gone into at great length. What difference does it make as to whether or not the Authority could do this thing more economically by using the Utilities' system? That presupposes that an agreement could be made, and under what terms the agreement could be made.

Mr. Fitts: Furthermore, the question is directly contrary to the mandate of the statute in one particular. It is based upon an assumption which is against the mandate of the statute which requires the Tennessee Valley Authority to give certain preferences to municipalities and cooperative organizations of farmers not operating for profit. Furthermore, the question has in it the element of selling at an advantageous price, as if this case involved a review by this Court of whether or not Congress could elect to dispose of its property according to a certain policy which it has declared in a statute, and as if this court were called upon to review the wisdom and economic soundness of that policy, rather than the constitutionality of it.

Judge Allen: The objection is sustained. You may have your exception.

Mr. R. T. Jackson: May we have our exception noted, please?"

I delivered a paper in Birmingham in 1924, having to do with the integration of the companies in the southeast. It may well be true that the persons who were actually responsible for the operation of the principal utility companies in the southeast had made a study of the possibilities of integration of those systems in 1921. I don't happen to know. I was familiar with the fact that there were already in existence a number of major interconnections in the [fol. 1601] southeastern companies in 1924. It is a fact that a very highly integrated system has been developed in the southeastern states at the present time. I cannot tell what led to the developments or what was in the minds of the men who did it. I was not employed to develop any interconnection with the southeastern companies after my speech in

Birmingham in 1924. I am not claiming I led this change. I am saying that I made the speech as a matter of interest and in a general way the development followed along those lines.

I have made some predictions for load curves, but I do not understand what you refer to by my field studies. I have never been in Arkansas, except that I have been through it on the train. I have never been in Memphis.

“Q. Mr. Thomas, in your judgment, would a man engaged in the management and operation of utilities in Memphis, Arkansas, and Louisiana, and making frequent studies of those companies, their operations, the industrial and other conditions affecting them, be in better position to make an intelligent prediction of the load curve than a man who has never been in Arkansas and Memphis?”

A. I think quite the contrary is the usual thing. Let me explain, if you will. The people who understand these plants and their operations, their efficiencies, are the people who design them and the people who study the reports. The designs and the reports may be made a thousand miles away. Unless you have access to them, and know something about them, your presence in the city or state where they are does no good.

Q. That is, I understand, according to your view, absentee ownership and management is of great advantage?

A. I admit, Mr. Jackson, that if you have the designs and reports and live in Memphis, you might also be able to do the work too.”

In making these forecasts, I was considering the growth of the demand for power in the region and I did not make any allowance for the loss of load to the TVA. That has [fol. 1602] nothing to do with where the power was supplied from. I have shown the Commonwealth & Southern group on the exhibit as having something to do with the load curve. That is the use of power in the region which is served by that group. It doesn't take into account where the power is supplied from, but is the curve of the use of power. My figures on Defendants' Exhibit 133 and the supporting data (Defendants' Exhibit 134) are not to be taken as estimates of maximum demands of the various companies listed on these exhibits. It is the demand in the area, not necessarily the output of those companies, unless they are the ones to supply the area.

I do not know what the load curve trend is for the United States as a whole. That is a little too broad to answer and I do not believe anybody knows. The past historical load trend is up; I thought you were referring to the forecast trend. Until 1929, there never had been a decrease in any year below the year before. The trend has always been upward unless there was some very powerful influence to cause it to go downward. I cannot tell whether in the last 14 years the average has been five per cent.

For the Commonwealth & Southern group I have allowed an outage of $1\frac{1}{2}$ times the largest unit, and then I allow $7\frac{1}{2}$ per cent for swing in the business cycle, and other items. Then I allowed approximately 5 per cent for transmission failure and some other causes I mention. I did not say that these percentages would not be steady, but the misfortunes would not happen at the same time. I did add these three things together in getting my percentage of reserves. I chose them to get it this way. In addition to that I did not allow 15 per cent for machine failure on certain reserves. When I came to consider in what way steam generators would generate power on a possible load curve, I assumed [fol. 1603] that would be only 85 per cent of the capacity of the machines in use, which has nothing to do with the reserve capacity. I do not suppose that there is any figure known as the average output of steam generators in utility operation. I have some idea, it is very variable. Some companies have better luck than others, and it varies according to the type and age of the machine, but I don't know that there is such an average. If there is such a figure, I do not know it. As to whether I know from my studies that experiences have shown over a 25 year period that the steam generators are entirely dependable, not merely for when they are needed, but in case they might be wanted and not actually needed, for 96% of the time, I have seen different statements made from time to time, studies by individual companies, and a limited experience on particular types of machines, but I do not believe that there are any general statistics that are of general application. I do not think I was on a committee that issued such figures. I was not on the Prime Movers Committee. It must have been some other Thomas. I have never been on a committee of the Edison Electric Institute and I do not know what report you have in mind. They made many reports. I have not seen this report for 1936.

I do not know that I stated exactly that the largest unit of a system, such as the Commonwealth & Southern, might be out for overhauling during the period of low water, but it might be. I know that it is the intention that on a system such as the Commonwealth & Southern with predominantly hydro power, steam units are always overhauled during periods of high water, but they cannot always choose. If they have an accident or something suspicious, they have to look it over without waiting for the time to do it. Referring to my statement about the normal overhauling that I likened to the examination of a high priced automobile, it is the intention in any prudently managed company with hydro [fol. 1604] power to have the normal annual overhauling at a time when there is a surplus of hydro power and the steam is shut down anyway, but if one of those machines developed a vibration during the low water time, they have to look at it, or if the oil in the bearings becomes hot, they have to take it out. It is a fact that the matter of overhauling or regular maintenance and care will always be made during the season when there is an abundance of hydro power, and the steam plants are not in use, in the sense that that arrangement will be made whenever they have control of the inspection, but it sometimes happens that it is evident something is going wrong with the machine, in which case they have to shut it down and handle it at the time. The distinction I have made in my testimony was between accidental throwing out of a machine, and the taking out of a machine intentionally for some precautionary work. In general to be of any significance from the standpoint of peak carrying capacity, the failure of the unit will have to occur in a particularly dry six months of a particularly dry year, but it may happen in some parts of the system that the failure of a unit might be so important that the interconnecting lines would not make up for it, but I cannot make any broad, general answer. That would be true with the usual transmission facilities in a general way. The dry year would have to be when the load was considerable, not necessarily at the exact maximum, but when there is a heavy load. The dry year in the territory of the Commonwealth & Southern from past records occurs about once in 13 years, depending upon what the definition of a dry year would be. An extreme dry year might come every fifty or one hundred years, like the

one hundred year flood. There is a difference between a wet and a dry year. It might be so that the records would show that an extreme dry year has occurred in the Commonwealth & Southern territory about once in 13 years, but I have not really checked it up. As to the probability of a [fol. 1605] failure that I described happening at a time when it will restrict the peak carrying capacity of the system, I have considered the possibility of very many accidents which might happen. Any one of them is improbable, but that there will be one or more of the large number of possible accidents is not so improbable. The probability of a failure that I have described as happening, such as the appearance of a vibration in a particular generator at the time of a dry time, is a very remote possibility as far as that particular machine is concerned. I made no special assumption as to how long the particular machine would be out of service. If the steam generator were out only a short time on a hydro system, it would affect the capacity by the amount of load it was carrying, or it would affect the potential capacity by the amount of the capacity of the machine, whatever that is. There are extra generators on the hydro plants that can take up part of that slack if it is only out for a very short time, but it affects the capacity by how much drops out. If there is unloaded capacity of hydro machines and reservoirs, that would naturally take up whatever was dropped, provided the capacity was sufficient, and the reservoir was sufficient.

As to what would be the effect on the system carrying capacity of a machine being out only for a short time where one has a large amount of hydro with extra generators, if the original peak carrying capacity included all the units, hydro and others, and you drop a steam unit out, you must subtract that much. If you had not included all the hydro capacity when you established the system figure then, of course, it would not be necessary to subtract the capacity of the system unit which failed provided the hydro was available. In my studies, Table A in each case accounts for all of the capacity of the system, that is, all the usable capacity, all that is available. It does eliminate those various plants which I previously named.

[fol. 1606] I have described a great many things that might happen to the facilities of a utility and my testimony is based upon an assumption that during an extreme dry

year when the largest unit in the system is out of service for the six driest months, and when another unit half as large as the largest unit is also out of service during the six driest months, and if I miss my load forecast by this $7\frac{1}{2}\%$ factor, which I have previously described, and if also there are transmission line outages reducing the firm capacity by 5%, the results will be what I have testified about and shown on Defendants' Exhibit 133. It is not conservative to say that the probability of the coincidence of all these factors is less than one in 500,000 years. The percentages and this machine and a half which I have allowed here are the discounted results of a great many accidents which might occur. The question of probability has been taken care of in the choice of these percentages. They would be very much larger percentages if I did not assume that many of the misfortunes would not happen at the same time. It is necessary to consider that this Commonwealth & Southern system extends over several hundred miles in two or three directions with a very large number of plants, and a very large number of lines, and the trouble is not going to be confined to one machine here and one machine there. At college I made a study of the theory of probabilities in this connection. I do not think that the formula would fit and I did not apply it to my conclusions in arriving at the probable coincidence of these various factors.

Redirect examination:

My purpose in eliminating certain dams without substantial pondage from my calculations was because it is [fol. 1607] necessary to determine and to know what machine capacity will be available if called upon. In a dry year it is usually not possible to call upon all the hydro capacity due to shortage of water. Much capacity that would otherwise be wasted by a shortage of water can be preserved where pondage is available, that is, the capacity to save up the water running when the load is light and using it all at the times when the load is at the peak, which is the only time that the full capacity is required. To arrive at such a figure is a difficult operation if you are looking for numerical exactness. The difficulty lies primarily in uncertainty as to the minimum water that is available and as to the exact form of the load curve which has to be supported, and uncertainty as to whether water used in one plant on the peak only can be gotten to another plant on

the same river at such a time as to be used. In arriving at my conclusions, I have assumed as potential available machine capacity the full capacity at all plants with reservoirs or pondage. This leaves a number of plants, the so-called run-of-the-river plants, without pondage capacity. They will be able to generate power from whatever runs through them twenty-four hours a day without pondage. This is a quantity which is difficult to determine. Fortunately for the success of these studies, this is a minor quantity and may be approximated. There is another factor which must also be approximated of considerably greater importance, which has relation to the ability to use the potential available load capacity at pondage and reservoir plants at its full value on the load curve. In view of the minor importance numerically of these two factors, I have cancelled one against the other. To explain a little more fully what I have referred to as another factor of difficulty in using the pondage units at full machine capacity on the system load, I would like to refer to the chart attached to Defendants' Exhibit 134, the typical daily load curve charge. [fol. 1608] This is a point exceedingly important, justifying the elimination of certain of these plants on the system which, unexplained, might be misunderstood. Referring to this chart in Defendants' Exhibit 134, it is shown that the use of the hydro machine capacity is in the upper shaded part marked "hydro". If that capacity is to be used, it must be used in that portion. That energy is derived from some 40 or 50 separate plants, I don't remember the exact number, and each must make its contribution. If a small plant, like one of those eliminated, is to make a contribution to that shaded area, and is also to use the full rated capacity, it can only do so for a time during the day which is limited by the limited amount of water; that is, if there is only 10% enough water to carry that machine at full capacity, it can only carry its full capacity for 10% of the day. The same will be true of all those plants. Referring to the curve, the load dispatcher has a problem of fitting the special requirements which must be met if these individual plants are to be maintained at their full capacity in this shaded area. I can briefly explain the difficulty by calling attention to the fact that this shaded area might be likened to a wall built of bricks. Each brick will represent the contribution of one of these power plants. When you make the condition that that power plant shall operate at its full

machine capacity, you have determined the shape of that brick. It can only operate for so long and the height of the brick is determined by the capacity of the machine. The length of time it can operate is determined by the amount of water and you have to take those bricks which somebody else has shaped and fit them into that particular curve. The shape of the bricks cannot be controlled and obviously no such operation can be done 100% perfectly. A further difficulty is that the shape of these bricks changes from day to day because the amount of water changes in the river. Still [fol. 1609] a further difficulty is that the shape of the curve changes from day to day because the shape of the load varies, and this must be done on the highest day of the year. It is in the recognition of the impossibility of using the 100% value, that I have discounted the total by leaving out some of these smaller plants which overbalance, I may say, a certain gain that will come from the run-of-the-river plants passing the river water. I am referring to available machine capacity though it involves, of course, the use of energy. In discussing these eliminations, I was talking about the capacity eliminations.

Referring to specific cases, the Hales Bar plant is eliminated for a somewhat different reason. That is a more important plan and is not reported as having any drawdown in the pond, or as having any pondage, and I presume that is because there is an Army regulation which prevents their storing any water at low water, so that if those regulations are observed it would not be possible to use that plant for peaking.

With reference to Ocoee No. 1 and Ocoee No. 2, the plant with the pondage on the Ocoee River is below the plant without the pondage.

Referring to my estimates of growth of demand up to 1943 shown on Defendants' Exhibit 134, my estimates are based upon past experience in the development of the industry and uses of electricity and are made taking into account the almost universal trend for the natural increase of power with the growth of the country and growth in the use of electricity and increase of power in industrial operations.

The long transmission line to which I refer is from Boulder Dam to Los Angeles, which is between 270 and 284 [fol. 1610] miles long and has a voltage of 287,000. These are two separate transmission lines on separate power structures and there is a generating plant at the end of the

line in the City of Los Angeles. There are also synchronous condensers at the receiving end of the line.

My estimated demand is not a proper basis of estimating adequacy of the facilities of these four groups to serve the estimated demands in the territory which they serve, because it takes the sort of study I have made here to determine such a question.

Recross-examination :

As to whether, when I stated that Ocoee No. 2 was a plant without storage capacity, I understood that the plant's storage capacity was on the same river but of a different name, there are two plants on the Ocoee River named Ocoee No. 1 and Ocoee No. 2 of The Tennessee Electric Power Company. Those two plants are together. There is another plant on the river further up. The Tennessee Electric Power Company has a plant on the Toccoa River, in Georgia, which is the same river but with a different name, above those plants. That is the Blue Ridge plant and I am familiar with that plant. It is some twenty-five to thirty miles above the other two plants. I do not remember that the dependable firm capacity of Ocoee No. 2, as reported to the Federal Power Commission, from which I got my data, is 18,000 kilowatts. I did not use those dependable capacities in my studies. I made an energy study. A competent system planner should know how long it takes for water to flow from one plant to another, and the size of the ponds, and what would be the best way to use them. It is possible to know that, but the time taken is not the same under all conditions. The water flows much faster when it [fol. 1611] is high than when it is low, but I suppose it is possible to know that. I should think that the system operator has to know that and regulate the operations of the company on that basis. I have those factors in mind and I have made allowance in my figures here for the small uncertainties that come from those matters that we are not able to calibrate and measure. It is not fair to say that I have made allowance by decreasing the capacity, the allowance being made upon my lack of information about the facilities so that I would be able to express an intelligent opinion. There are factors there which cannot be calibrated by anybody.

(The witness was excused.)

[fol. 1612] Counsel for defendants then offered in evidence and the court received as Defendants' Exhibit 135 the stipulation entered into between the parties concerning the stock ownership and the relationship of various Complainant companies.

Counsel for defendants offered in evidence and the court received as Defendants' Exhibit 136 the stipulation entered into between the parties concerning the TVA transmission line and substations and lines served by TVA.

KENNETH E. HAPGOOD was called as a witness on behalf of the defendants and, having been first duly sworn, was examined and testified as follows:

Direct examination:

I am 38 years old and reside in Chattanooga. My present position is assistant engineer of design and construction in the Department of Operations of the TVA. I graduated from the Worcester Polytechnic Institute in 1923, with the degree of Bachelor of Science in Electrical Engineering. I am an associate member of the American Institute of Electrical Engineers. I spent six years with the General Electric Company, two years of this time being spent in the alternating current engineering department on design of water wheel generators, in which large water wheel generators were designed. This section also designed synchronous generators and condensers. I spent three years in the high tension section of the central station engineering department of the General Electric Company, in Schenectady, and during this time I was the representative of this section on the alternating current machinery standards committee. This section acted as a liaison section between the various district offices and various design sections of the factory on matters of engineering. The section also acted as consulting engineering section for such customers as required [fol. 1613] engineering to be done. Among the work that I did in this section was consulting work on excitation designs, of condensers and the improvement of the stability of machines, and I made studies on stations with respect to breakers, etc. The Greenville loop of the Duke Power Company, in South Carolina, was one of these studies. The section

handled various parts of the country and foreign properties, and during the time I was there I handled work on the Southeastern States, except Florida, on properties in California such as the Southern California Edison, the California-Oregon Power Company, and properties in Japan and Mexico, such as the Nippon Electric Company, in Japan. During this time I also spent some six months with the Alabama Power Company on an exchange basis.

I have been with the TVA in the division of design and construction approximately $3\frac{1}{2}$ years. This division handles all of the design and construction for transmission lines and substations of TVA, except substations or switching stations at the hydro plants, which are a part of the dams and are handled by another design section.

I was for three years with the Southeastern Engineering Company and Allied Engineers, Incorporated, in Birmingham, Alabama. Most of this time I spent doing engineering work on the Georgia properties and was what some companies call sponsor engineer. I was liaison engineer between the operating department and headquarters engineering offices in Birmingham, and during this time we made extensive studies as to providing reliable service for the City of Atlanta. These studies were completed and gradually put in execution. We also made studies on improving the generating plants of the Georgia Power Company, doing what work was necessary to bring the excitation systems up to what was a reasonable standard.

During the course of my duties I have become familiar with the physical transmission properties of TVA and the [fol. 1614] properties of the customers whom it serves at wholesale.

The map (offered and received in evidence as Defendants' Exhibit 136-A) is an exact copy of the map which is attached to the stipulation on lines and substations. There is one slight error and that is that a short section of line between Booneville, Mississippi, and the Lee County line should be shown on the map as constructed. It was inadvertently omitted. The line from Booneville to Tupelo was purchased. The line which was omitted is approximately fifteen miles long and has a capacity of 44,000 volts. We constructed a short section of 44 KV line to complete the line from Booneville to the Lee County line. The solid lines on this exhibit are the lines which were purchased and re-

tained by TVA under the contract of January 4, 1934. The lines in Alabama and Mississippi which are shown in solid green were purchased under the contract of January 4, 1934, and retained. There are two short pieces of line which are not covered by the legend. The line from Iuka, Mississippi, to Golden was purchased by TVA under the contract of January 4, 1934, and sold to the Tishomingo Electric Power Association. A short section of 12 KV line very slightly west of New Albany, Mississippi, to the Benton County line was sold to the City of New Albany. The small green cross-hatched line by Norris Dam is an 11 KV line about eight miles long which was purchased from The Tennessee Electric Power Company.

Examination by the Court:

The lines that were purchased under the contract of January 4, 1934, in Alabama were purchased from the Alabama Power Company and in Mississippi from the Mississippi Power Company.

Direct examination continued:

The map (offered and received in evidence as Defendants' Exhibit 136-B) is entitled "Rural Lines Owned by Municipalities and Cooperatives Purchasing Power from the TVA [fol. 1615] and Rural Lines Owned by the TVA", and was also included in the stipulation. This map was prepared as of October 15, 1937. The areas blocked out with blue lines are the areas in which various cooperatives are operating having wholesale contracts with TVA. The areas blocked out in yellow show as of that date the properties which TVA was operating directly. There is an area around Norris Dam, for instance, and an area in the northwest corner of Alabama. In addition, there are three short sections of low voltage line, 12,000 volts, which the TVA owns and operates. One of these is from Bolivar, Tennessee, to Somerville, Tennessee, and the other one is a short stretch of line from Benton County, Mississippi, to Holly Springs, Mississippi, and a very short stretch of line from New Albany in Union County, Mississippi, to approximately the Pontotoc County line. Since this map has been prepared, the Lincoln County Association took over the property which it had a contract to acquire and is now in direct operation on its own, and we are selling power at wholesale to that

county. The different cooperatives are distinguished by Roman numerals, which the legend completely shows.

Examination by the Court:

There are 21 cooperatives on this map, and with the addition of Lincoln County there are twenty two.

Cross-examination:

This is intended to be a copy of the stipulation map.

"Mr. Jackson: Second, it does not show the North Georgia Membership Corporation, which runs up into Tennessee, as I understand it.

Mr. Fitts: We left that out because—we had it on one time and we left it out, but, on account of the suggestion of the Court—this is an exact duplicate of the map that was stipulated, Mr. Jackson as being correct.

Judge Allen: You concede that the North Georgia Membership Corporation operates two lines in Tennessee? [fol. 1616] Mr. Fitts: I think that is established in the record, and I think the record shows how many."

Direct examination continued:

In the course of my duties I have become familiar with the physical properties conveyed to TVA by the Alabama Power Company and the Mississippi Power Company under the contract of January 4 and I have become familiar with the identity of the physical properties which were optioned by The Tennessee Electric Power Company under the same contract.

The map (offered and received in evidence as Defendants' Exhibit 137) is entitled "Lines and Substations of TVA and Lines and Substations Purchased or Optioned under the contract of January 4, 1934 by Authority from Commonwealth & Southern Companies." As shown under the legend, the solid green lines are the lines which were purchased, in Alabama from the Alabama Power Company and retained by TVA, and in Mississippi from the Mississippi Power Company and retained by TVA. The lines shown in green with two blocks breaking the line are the lines which were purchased and resold. Those appear in the state of Mississippi. The line from Iuka to Golden in Mississippi was purchased by TVA from the Mississippi Power Com-

pany and resold to the Tishomingo County Electric Power Association. The other section of the line in the stipulation in Benton County, Mississippi, was also purchased from the Mississippi Power Company under the contract of January 4, 1934, and sold to the City of New Albany. The blue lines shown around Norris Dam were the lines which were under option under the terms of the contract of January 4, 1934 from The Tennessee Electric Power Company, and the small green line running out of Norris Dam has an 11 kv. line which was purchased from The Tennessee Electric Power Company. There are other lines in Alabama out of Hartselle, Alabama, which were purchased under this [fol. 1617] contract of January 4, 1934 and resold to the Joe Wheeler Electric Membership Corporation.

I am familiar with the loads which the TVA is now serving or has a contract to serve and with the transmission systems and load centers of the complainant companies.

The map (offered and received in evidence as Defendants' Exhibit 138) is entitled "Transmission Facilities of TVA and of Private Utilities". The area was selected to show the lines of the complainant companies which were near TVA dams and to show the nearest dams to non-complainant companies of any magnitude. There are lines of complainant companies that are not shown there. The map is not large enough to include them all on the scale on which the map is made and the map does not identify the lines as belonging to complainants or non-complainants. The Duke Power Company is interconnected with these utilities, but the Kentucky Utilities Company has no connection in the area in this part of Tennessee. There is another small company in this area in Tennessee, the Hydro Electric Corporation. The Aluminum Company transmission lines are shown in the area in aluminum color.

Examination by the Court:

The lines of the ~~Commonwealth & Southern~~ companies, particularly the Alabama Power Company and Tennessee Electric Power Company are connected to Wilson Dam, and they go right by Norris Dam. There is a connection through Chickamauga Dam in Chattanooga, Tennessee. Generally speaking these lines come within two hundred miles of any dam.

Direct examination continued:

The lines of complainant companies are shown in red. I do not attempt to limit the lines of the complainant companies in any manner. I took the lines of the complainant [fol. 1618] companies from exhibits which they submitted. The map shows Wilson Dam's connections with the Alabama Power Company, and this connection north of Wilson Dam with the Southern Tennessee Power Company which is a wholly-owned subsidiary of The Commonwealth & Southern Corporation. It also shows a connection at Norris Dam construction substation with The Tennessee Electric Power Company. This connection is still in existence and the substation supplies power to Norris Village and for station service at Norris Dam when necessary under the interchange agreement in the contract of January 4, 1934. That line was used in the construction of Norris Dam and the substation will shortly be removed. There is a 44,000 volt connection at Chickamauga Dam near Chattanooga which was used to take power from The Tennessee Electric Power Company in the early stages of construction. This connection is now used as a standby and the power is supplied to the Chickamauga construction project by way of the Watts Bar project line, which is a TVA line serving TVA power. The black line at Guntersville Dam was a 110,000 volt connection with the Alabama Power Company which supplied power for the dam on the construction project. This connection is now operated open. The power is supplied to Guntersville from Wheeler Dam by the Guntersville line which is owned by TVA. When a connection is open, power cannot be taken across that connection. It must be either closed by closing the switch or making a wire connection similar to the switch in your house.

The nearest line of any company, other than companies of the Commonwealth & Southern group, the American Gas & Electric group or the Electric Bond & Share group, to any TVA dam constructed or under construction, would be the Kentucky Utilities Company at Pineville, Kentucky, which is approximately 45 miles north of Norris Dam. The nearest utility other than those three groups to any dam on the main stream, constructed or under construction, would be the Duke Power Company, in South Carolina, near the [fol. 1619] western boundary of Oconee County. That is approximately 115 miles from Chickamauga Dam. The

small utility of the Kentucky-Tennessee Light & Power Company which has a line at McKenzie, Tennessee, is approximately 75 miles from Pickwick Landing Dam, which is the nearest dam to that property. The nearest utility of reasonable magnitude to Wilson and Guntersville Dams, excluding the Commonwealth & Southern, the American Gas & Electric and the Electric Bond & Share groups, would be the Duke Power Company at some 250 miles from Wilson Dam. The smaller company which I have mentioned at McKenzie, the Kentucky-Tennessee Light & Power Company, is something like 100 miles from Wilson Dam. The Duke Power Company is about 240 miles from Wheeler Dam and the TVA has the two possible connections to the Kentucky-Tennessee Light & Power Company and the Kentucky Utilities Company at Springfield, Tennessee, and Franklin, Kentucky, which are around 100 miles. The Duke Power Company is approximately 180 miles from Guntersville Dam and these other companies, the Kentucky-Tennessee Light & Power Company and Kentucky Utilities at Springfield are something like 125 miles away and Franklin is probably on the order of 140 miles away.

I have a copy of a stipulation between the parties on the lines and substations of TVA. Exhibit B to that stipulation lists transmission lines in a table. The lines under "B", Roman numeral I, in that table were purchased from the Alabama Power Company under the contract of January 4, 1934. These lines consist largely of 44,000 volt lines, specifically a line from Wilson Dam to Hobgood, Alabama, a 44,000 volt line from Hobgood to the Alabama-Mississippi state line, a 44,000 volt line from Hobgood to Russellville and Rockwood, another line to Moulton, a 44,000 volt line around Decatur, Alabama, from Decatur to Hartselle, and from Decatur east and then north to Athens, Alabama, and one short stretch of 22,000 volt line from the Alabama-[fol. 1620] Mississippi state line to Red Bay, Alabama, in Franklin County.

Lines under "C", Roman numeral I were purchased from the Mississippi Power Company and consist largely of 44,000 volt lines extending from the Alabama-Mississippi state line to Iuka, Burnsville and Corinth and from Burnsville to Booneville. There is also a stretch of line from Tupelo to Oklona, Mississippi. The total shows a 22,000 volt line from Golden to Fulton, which was included.

Under Roman numeral II, "A", there are shown plant tie lines which serve the necessary function of permitting the free transfer of power from one plant to the other, thereby making the plants flexible. They are a substantial and necessary part of the plant construction program. If TVA had not constructed these plant tie lines, it would have had to rely upon the facilities of the Commonwealth & Southern companies in the area to serve the properties of plant inter-ties. In my opinion, these facilities would not be adequate to serve this purpose for the plants that were constructed or are under construction. There were no utility lines of any consequence between Wilson and Pickwick Landing Dams.

The lines listed under II-B and III and IV, which do not come under either of the above classifications, that is, they are not lines purchased, or tie lines, but are properties located wholly or partially outside the ceded area, are the Columbia-Dickson line, the Pulaski-Columbia line, the Pickwick-Jackson line, the Jackson-Bolivar line, the Columbia-Monsanto No. 1 line, the Wheeler-Columbia line, the Santeetlah-Hiwassee line, the Chickamauga-Friendship line, the Columbia-Monsanto No. 2 line, the Norris-Alcoa line, the Pickwick-Memphis line, the Jackson-Milan-Trenton line, Norris-Knoxville, the tie line with the Arkansas Power & Light Company and the Columbia-Victor line. Under IV, there is the Columbia-Murfreesboro line, the Pulaski-[fol. 1621] Fayetteville line, and the North Memphis-South Memphis line.

Examination by the Court:

All of these lines I have mentioned are either wholly or partially outside the ceded area and the other lines are inside the ceded area, except for one possible exception, I see I omitted the Bolivar-Somerville line in Tennessee.

Direct examination continued:

These lines serve the function of delivering power to the municipalities and cooperatives with whom TVA has wholesale contracts and they also serve industrial customers of TVA outside of the ceded areas in Alabama and Mississippi. The Santeetlah-Hiwassee line may be considered an exception, since its function is to provide construction power to the Hiwassee project.

These lines under II-B and III and IV serve load and contract commitments of TVA with the City of Memphis and also the Arkansas Power & Light Company connection at Memphis, and also serve the loads around Jackson, Tennessee, consisting of Trenton, Milan, Jackson, Bolivar and Somerville, and the two cooperatives in that area, the Gibson County Electric Membership Corporation and the Southwest Tennessee Electric Membership Corporation. All of these customers have wholesale contracts with TVA.

The lines which serve the loads in the area around Columbia, Tenn., the Monsanto Chemical Company and the Victor Chemical Company, which have power contracts, will also serve the loads at Dickson, Pulaski and the electric membership corporations consisting of the Middle Tennessee, the Duck River and the Lincoln County Electric Membership corporations. All these cities and cooperatives have wholesale contracts with TVA. The lines around Norris will serve and deliver power to meet the TVA contracts with the City of Knoxville and with the Aluminum Company of America at Alcoa. The line from Athens, Tennessee, to [fol. 1622] Decatur is not in operation right now. The line from Decatur, Tennessee, to Dayton is in operation and serves the city of Dayton and the Meigs County Electric Membership Corporation, both of which have wholesale contracts with TVA. I have omitted the North Georgia Electric Membership Corporation in view of the Court's ruling.

The TVA could not have delivered loads outside of the ceded area without using the lines of the Commonwealth & Southern companies or constructing lines of its own. There is one area, particularly in West Tennessee, in which there were no lines which could have been used to deliver TVA power to our customers. In those areas lines would have to be constructed, even if it were assumed that an agreement could be reached for the use of lines.

"Q. Mr. Hapgood, in your opinion do these lines which you have mentioned and explained, constitute an unnecessary duplication of existing transmission facilities in the area, or are they useful and valuable additions to the existing facilities?

Mr. R. T. Jackson: I object to that question. If it is material, it is a question to be determined by the Court.

Mr. Fitts: I don't think so.

Mr. R. T. Jackson: And I object further to his qualifications.

Judge Gore: Will you read the question again?

Mr. Fitts: Yes. I would like to make one statement before I read it. It seems obvious to me that the question of usefulness and desirability of a transmission line is a question of fact and also of expert opinion. I don't see how it could possibly be a question of law for anybody.

Judge Gore: The thing I wanted to know about the first part of the question was whether you were asking for a conclusion.

[fol. 1623] Mr. R. T. Jackson: I object to the question as double, and also that it is calling for a conclusion.

Judge Allen: The Court has permitted the complainants to ask questions of this nature. The decision on the ultimate question of fact is, of course, for the Court, but the Court will permit the witness to answer this question.

Mr. R. T. Jackson: May we have our exception, if the Court please?

A. Before answering that question, I would like to define "Duplicate." There are two meanings of this word "Duplicate"; one of them is a supplementary facility. All large load centers are supplied by two or more transmission lines to render reliable and dependable service, and this is as necessary, of course, as having spare generating capacity. The other meaning of the word "duplicate" is a facility which serves no function not already adequately and dependably served. I take it your question means that you have the last meaning in mind?

By Mr. Fitts:

Q. I have.

A. On that basis, generally speaking, it is my opinion that those lines are not a duplication of existing facilities. The Pickwick Landing Dam-Memphis line may be used as an example of this. That line was constructed to meet the contract with the city of Memphis, Tennessee, and in addition to that function, it will fulfill the function of supplying some 35,000 kilowatts to the Arkansas Power & Light Company at Memphis, Tennessee. As shown in Mr. Rankin's testimony, there is or will be a shortage of power in the valley companies of the Electric Bond & Share group in that area, so I don't consider this line as a duplication.

That shortage, by the way, is even with this 35,000 kilowatts of capacity from the Tennessee Valley Authority. The Pickwick Landing-Jackson Line—

Q. I wish you would discuss next the line from Norris to Alcoa, if you will.

A. The line from Norris to Alcoa was constructed to meet our contract with the Aluminum Company of America. This line may be called upon, or the Aluminum Company of America, rather, may call upon, the authority for some 112,000 kilowatts of capacity. The line will not only serve them but will serve a valuable supplementary source to the connections already existing between the Aluminum Company of America at Alcoa and the Utilities in that area. It is my opinion that this line is a valuable supplement to existing facilities. Taking a line of a different character, [fol. 1624] there is a 44,000 line of low capacity between Columbia and Murfreesboro, Tennessee. This line is necessary to provide reliable service to our wholesale customers, the Middle Tennessee Electric Membership Corporation and the Duck River Electric Membership Corporation.

Q. Now, would you discuss the line from Pickwick Landing Dam to Jackson?

A. The line from Pickwick Landing Dam to Jackson is already supplying some 3000 kilowatts of power at Jackson, and, in addition, the West Tennessee Power & Light Company in that area is supplied by a 110 KV. line, I believe it is, from Memphis to Ripley, Tennessee, and then by a line from there to Jackson, Tennessee, and in addition, has installed capacity of some 5,200 kilowatts of generator capacity. In Mr. Rankin's testimony and bits it shows that these various plants of the West Tennessee Power & Light Company are good for approximately 4,100 kilowatts on the peak in terms of firm capacity. Their records would indicate that the load of the West Tennessee Power & Light Company now is on the order of 6,000 kilowatts, and, using the figures produced in evidence by Mr. Rankin, the load may reach 7,500 kilowatts by approximately 1939-1940. Obviously, if the line from Memphis to Ripley should fail these same 5,200 kilowatts of generating capacity would not be able to carry this 8,000 or 10,000 kilowatts of load. There is another potential shortage not included in the figures I have just mentioned, and that is the Kentucky-Tennessee

Light & Power Company has a potential shortage of 3,000 to 5,000 kilowatts north of Milan and Trenton, Tennessee.

Q. Now, will you discuss the line from Norris to Knoxville?

A. The line from Norris to Knoxville in my opinion, is not a duplication of facilities. This line was constructed to meet the contract which the Authority had, but, in addition, if suitable operating agreements are made, it can be connected to the facilities of the Tennessee Electric Power Company, the Carolina Power & Light Company and the Tennessee Public Service Company, at the Arlington substation in Knoxville. This would provide a very flexible means of transferring power around. If any quantity of power is to be transmitted from Norris to Knoxville, dependably transmitted, two circuits would be required, and this line would serve as one of those two circuits. Looking over the area, Mr. Rankin and Mr. Middlemiss in their testimony as to loads and capacities showed a demand of some 231,000 kilowatts on the Tennessee Public Service-Carolina Power & Light, Holston River System in 1939, and some 985,000 kilowatts of demand on the Commonwealth & Southern groups, also showing an excess of dependable capacity over and above the loads of 20,500 for Carolina Power & Light-Tennessee Public Service Holston River group, and on the order of 65,000 for the Commonwealth & Southern groups. Adding these various capacities, it shows only a reserve or excess dependable capacity approximately 7 per cent on the two systems. So, this connection, if suitable agreements were made, between Norris and Knoxville will very materially assist the various systems at that point."

The total number of miles of transmission lines of 22 KV. and over which have been constructed, are under construction or are authorized by the Board of the TVA is on the order of 1322 miles. In addition to this the TVA owns and operates approximately 216 miles of line of this character purchased from the Alabama Power Company and the Mississippi Power Company under the contract of Jan. 4, 1934, in Alabama and Mississippi, and approximately 8 miles of line which was transferred to TVA under the TVA Act by the War Department at Wilson Dam, making a total of approximately 1545 miles of transmission line of all characters.

I have studied the statistics supplied by the Edison Electric Institute on the extent of the electrification of farms in the years from 1931 to 1937 in the Tennessee Valley states of Virginia, North Carolina, Kentucky, Tennessee, Alabama and Mississippi. The percentage of rural electrification of farms receiving central station electricity as compared with the total number of farms in the states as of December, 1931, was in Virginia 7 per cent, in North Carolina 3.6, in Kentucky 3.1, in Tennessee 3.3, in Alabama 4.8 and in Mississippi 1.1 per cent.

Examination by the Court:

The definition of a farm as used in those tables by the Edison Electric Institute is the same definition as is expressed in the U. S. Bureau of the Census, which is, I believe, three acres or more on which a person makes a living. [fol. 1626] The percentages apply whether it is a farm of 1500 acres or a farm of three acres, regardless of the number of acres, and it includes a homestead which has some one living on it.

Direct examination continued:

The same figures for the year 1932 were in Virginia 7.4 per cent, in North Carolina 3.5 per cent, in Kentucky 3.4 per cent, in Tennessee 3.6 per cent, in Alabama 4.5 per cent, and in Mississippi .8 per cent. The statistics are not particularly clear as to whether the decrease resulting in Mississippi in 1932 was due to an increase in the number of farms, or a decrease in the number of electric services, but I would assume it resulted probably from a combination of them both. The same figures show as of December 31, 1936; in Virginia 10.3 per cent, in North Carolina 8.2 per cent, in Kentucky 3.8 per cent, in Tennessee 8.1 per cent, in Alabama 5.5 per cent, and in Mississippi 2 per cent. The same figures for 1933 show for Virginia 7.9 per cent, for North Carolina 3.4 per cent, for Kentucky 3.4 per cent, for Tennessee 3.6 per cent, for Alabama 4.2 per cent, and for Mississippi .8 per cent. The comparison in Tennessee between 1933 and 1936 is the difference between 3.6 per cent and about 8 per cent in 1936, and in Mississippi in 1933 it was less than one per cent, and two per cent in 1936. The percentage of rural electrification in the Valley States is rela-

tively low as compared to the national average and the other states.

The TVA has been constructing transmission lines of 23,000 volts and above in the last four years at the rate of approximately 330 miles a year of all classes, and if my mathematics are correct, at that rate it would be somewhere on the order of 35 to 40 years before TVA could have constructed 12,000 to 15,000 miles of transmission lines.

[fol. 1627] Cross-examination:

I am in the Design and Construction Department and work under Mr. Woodruff. Mr. Woodruff works under Mr. Sullivan. It is not correct that Mr. Sullivan works under Mr. Evans in that department. Mr. Evans is in another division than the Electrical Department. It is my understanding that Mr. Sullivan works directly under Mr. Blandford and reports to him, as distinguished from Mr. Evans. I am sure of that.

I graduated from Worcester Polytechnic Institute in 1923. I was with the General Electric Company for a period of approximately six years. While I was with the General Electric Company, I was engaged in consulting work having to do with companies in various parts of the world. As to whether I ever visited any of these customers' systems, most of my visits were made in southeastern territory. I never visited Tokio and various other places which I mentioned. As a matter of fact, when I was with the General Electric Company, the procedure was if an order came in for equipment, our department, as one of its functions, checked the customer's order to see whether it would serve the purposes for which the customer desired it. Then, if it happened to fall to me in that department, I went to the design section of the company and asked them to design proper equipment, if necessary, and in any event to make an estimate of the cost. After I got that information from the design department of the company, I might write up a specification of the customer's order and then I would turn that specification over with the design, if a design of any kind was received from the design department, and the estimate of cost, to the commercial department, which would attempt to close the deal for the business. We did not handle direct commercial negotiations. However, we did [fol. 1628] handle engineering questions and conferred on

engineering data with customers when the customers requested the engineering division for the information.

Examination by the Court:

I was one of the engineers who gave that information.

Cross-examination continued:

I was in the department which I have been discussing, in which there were a great many engineers. It would take a great many engineers to check the orders which came in to a large company like the General Electric.

After I left the General Electric Company, I was employed by the Southeastern Engineering Company in Birmingham, Alabama. As to whether I was employed at any time by the Dixie Construction Company, I believe the pay checks were signed by the Dixie Construction Company. However, all the stationery was "Southeastern Engineering Company" until the Allied Engineers took it over. The work of that organization involved planning, studies, preparation of purchase specifications, for substations and things of that character. As to whether that was one of the service organizations connected with the utility companies in the southeast, I do not know what you call it. We did the engineering work on the primary system for the companies in that group. That was the southeastern group as it was then known. It fulfilled the function of an engineering service for these utilities. I left that organization in 1931. I was substantially out of employment from then until I entered the employ of the TVA in 1934.

The statistics issued by the Edison Electric Institute which I gave with reference to rural electrification covered [fol. 1629] six states, that is, all of the states touching the Tennessee Valley with the exception of Georgia. It is a fact that a good many of the farms in those southeastern states are operated by tenants. As to whether I have made studies to determine whether or not there is available rural service which is not being utilized by the farms along existing lines in the rural areas, we have done sufficient work to know where service is available and where it is not. I have not made such studies personally but it has been done under my supervision. I do not know whether practically 65 per cent of the farms in Alabama are operated by tenants. As to whether my studies carried me that far,

I did not think that was entirely pertinent to the studies and I did not try to make that particular distinction. As to whether it is a fact that farm income is of importance in determining the number of consumers able to acquire such service, in my opinion, you can compare studies of states and can find in such a state as North Carolina that the percentage is twice that of Tennessee as to income, but the farms electrified are practically the same, or were in 1936. I know that it requires an investment on the order of \$100 for each rural customer to wire his home and purchase sufficient equipment to use 400 kilowatt hours per year. I do not know that it would require approximately a \$2,000 investment on the average by the farmers to use TVA minimum requirements of 662 kilowatt hours per mile of line per month. As to whether I did not study that either, I am not sure of the figure. I would have to go back. As to whether I did not regard that as material, I do not remember the figure. I think I have a few figures on the trends of farm cash incomes in these southeastern states for the past ten years. There are some states in which the farm incomes varied in a larger measure than in others. [fol. 1630] There has been no exceptionally large growth or exceptionally large decrease in farm income in the six states. I do not say there has been none, I said there had been no exceptionally large change. As to whether I know from my studies in Alabama, for instance, that the average annual cash income for the farm for the period of 1924 to 1928 was \$176,000,000 and for the same state in 1932 it was only \$58,000,000, I do not remember those figures. I do not have them with me. As to whether I ever had them, I was not much interested in going back to 1924, I was interested in existing conditions. Assuming that the farm income did decrease in Alabama from \$176,000,000 to \$58,000,000 during that period, I would regard that as a substantial reduction, but I think those reductions are reflected in varying percentages of farms electrified. The only method you can use in considering the state is the average income for the particular farms for the states. In comparing the statistics by states, I would more or less be forced to consider the average income per farm rather than the income of one state as compared with the income for another state.

As to whether the total farm income in one state as compared with the total farm income in another state would not mean anything in determining the possibilities of farm electrification, except when it was reduced to income per farm you will have to consider the income per farm. If you are referring to a particular area, then you must consider the particular condition in that area. From my studies and experience, I have not found that it is necessarily true that farm tenants are less inclined to new and progressive ideas, and less inclined to install electrification on farms than the owners occupying their own places. As to whether I have found it one way or the other in my studies, you will find some that hesitate and some that don't. I [fol. 1631] don't know. Given proper conditions, tenants are just as likely and just as ready to go to the expense of rural electrification as the owners who live on their own farms.

As to whether I have made any actual surveys in Alabama in the field to study the number of potential rural customers, I believe that some kind of surveys have been made in the areas in which we operated to study the number of potential rural customers. I do not know how many miles of line could be built in any section of Alabama and obtain five customers or more per mile. The density of customers per mile does have a bearing on the cost and feasibility of providing service for customers or farms, the more customers you have per mile, the less cost per customer, and conversely, the fewer, the more cost. I could not give the exact figure on the average cost per customer to string a single phase rural line to serve five customers per mile. I should say it would be something in the neighborhood of \$200. As to whether it is about \$206 per customer, it is on the order of \$200. I could not give the exact figure. As to whether, if there were only four customers per mile, the cost would go up to about \$245 or \$250, it varies in proportion to the number of customers. I have nothing to do with the particular feature of the business which determines the minimum number of average customers per mile of rural line required for the construction of new lines. As to whether I know anything about that, that is a matter of policy in which we have no part.

In my study of the rural electrification situation in these states I did not quite agree with the figure from the Agri-

cultural Census that in 1935 the average cash income per farm in Tennessee was \$405. The figure I reached was \$564, which is the figure for gross income and not cash income. The figure for the gross income which I ascertained for Alabama per farm in 1935 was \$579. I [fol. 1632] could not tell one way or the other whether the 1935 cash income per farm was in Tennessee \$405, in Alabama \$430, and in Mississippi \$450. I haven't the exact figures to know how the average cash income per farm, which excludes the estimates made for consumption on the farm in these states, compared to the average for the United States, but I would judge it would be somewhat below. As to whether it would be very much below, I don't remember how much. I don't remember and would not want to say that the average for the entire United States was a cash income of \$1060. As to whether I recall from my studies whether the average cash income per farm on the Pacific Coast is on the order of \$2500 and over, I did not go into that. It has no bearing on the Tennessee Valley itself and I was not concerned at all. I made no study of these cash income statistics for farmers in the southeast and their relation to cash income for farms in states on the Pacific Coast and such other states as that. I was concerned with the Valley states and I was not interested in what happened in remote sections of the country, with respect to Valley states. As to whether I made any study of the cash farm income for the southeastern states and cash income for other sections of the country, I do not quite understand what you mean when you say "cash income". As to what is the gross cash income, money taken in as distinguished from vegetables, chickens, etc. used on the farm, the figures I read from my notes here, evidently were in dollars. I am willing to testify the figures I read for 1935 are average income in dollars for those farms. That is what my notes show. They show average income per farm, considering gross income of all farmers divided by the number of farms. If my memory serves me, I understand from my study of the statistics of the Census Bureau that it means the net gross cash income in terms of [fol. 1633] dollars. Without checking back to the sources again of my notes which terms it "millions of dollars farm income divided by the number of farms in the State", my testimony is that it is gross income in millions of dollars.

Cash income may include a number of things, I cannot remember that right now.

I cannot identify the document (offered and received in evidence as Complainants' Exhibit 918) in connection with my rural electrification studies as a copy of the Neighborhood Plan for rural electrification of the TVA as my division has nothing to do with it. It may be, it is headed "Electric Development, Department of Electricity, TVA, dated August 1, 1936".

"Mr. Fitts: Mr. Jackson, if that is a copy of the thing we gave you, it is authentic."

This document comes from the Service Department which serves separate functions and our Division is concerned only with design and construction. This Electric Division is concerned with other matters.

"Q. The reason I want to show you this Complainants' Exhibit 918, I understood you earlier in the cross examination to be unable to recollect the requirements of the TVA rural electrification so as to express any opinion as to the cost of equipment that it would be necessary to acquire, to carry out such a plan, and I direct your attention to this statement on page 1-A of Complainants' Exhibit 918, it is marked both page 2 and page 1-A:

"There is no fixed rule as to what is "enough business". This will vary, depending on the cost of the line and other factors. However, experience in other communities in the Tennessee Valley has shown lines are generally feasible when customers agree to install enough equipment to use an average of 662 kilowatt hours per month per mile of line; and where surveys reach this total, it has in most cases been possible to arrange for construction of the lines either through TVA or the Rural Electrification Administration. In over 20 counties of Tennessee, Alabama, and Mississippi, rural lines have been built or are under construction to serve farmers and in most cases they have been surveyed [fol. 1634] by this neighborhood plan, using the objective of 662 kilowatt hours per month per mile of line. It is generally agreed that this plan is more practical and workable than any other previously attempted."

I would like to ask if you have had that in mind in your studies of the rural electrification development and possibilities?

A. That is a matter of policy which is outside of the scope of our division. I was concerned with what had happened, not what was going to happen in these studies."

We design the lines to obtain the best possible. I presume that in Tennessee in the 1930 census figure the average density of farm homes costing \$500 or more per mile of road is 2.53; in Mississippi it is 1.31; and in Alabama 1.31. The figures I have from the Edison Electric Institute Bulletin do not quite agree with those figures.

Examination by the Court:

As to whether the only figures I studied were from the Edison Electric Institute Bulletin, those are the figures that I studied. Those are part of the figures that I studied. The only figures I testified about were from the Edison Electric Institute Bulletin.

Cross-examination continued:

As to whether I studied the Federal Census figures, I used the figures in the Edison Electric Institute Bulletin on that when I looked that up. I did not pay much attention to the farms per mile of road. I am sure that I did not study those specific Federal Census figures for those three states.

The document (offered and received in evidence as Complainants' Exhibit 919) is entitled "Production of Electricity for Public Use in the Tennessee Valley States and the Nation, month of July, 1937, preliminary report". It [fol. 1635] shows the details of the consumption of electricity and of the operations of cooperatives and the like in the territories where TVA was operating at the time. As to whether Cullman County, Alabama, is poor land or a good agricultural county with diversified farming, as I remember Cullman County there is some slight diversity. I could not state whether it was one of the most diversified agricultural counties in Alabama or in the southeast. Its population is largely white and very progressive and thrifty. As to whether it is my opinion that the people in that county would be better than ordinary prospects for the

use of electricity from rural lines; I should say that they would be as good as the ordinary prospects. It is quite largely a German population. I do not remember the exact date when TVA started serving electricity to the Cullman County Electric Membership Corporation, but I think it is on the stipulation.

“By Mr. R. T. Jackson:

Q. Can you tell me whether this Electric Membership Corporation has a clear field for the development of the business in its territory in Cullman County?

Mr. Fitts: We object to that question, may it please the Court, on the grounds that it is irrelevant and immaterial. Furthermore, it is cumulative.

Mr. R. T. Jackson: It is a foundation question; that is what it is.

Mr. Fitts: There is evidence in the record completely and thoroughly as to the situation in Cullman County.

Mr. R. T. Jackson: No, it is not.

Judge Allen: The objection is sustained. We consider the question somewhat vague as ‘Predictable future’.

Mr. R. T. Jackson: I note an exception, and may I say that the question of whether or not any electric company has a monopoly in the area it serves, or whether it is being subjected to competition is not speculative.

Judge Allen: That was not the question, Mr. Jackson. You will remember that is not the question.

[fol. 1636] Mr. R. T. Jackson: That is what I am trying to ask.

By Mr. R. T. Jackson:

Q. May I inquire whether the Cullman County Electric Membership Corporation has a monopoly of the territory in which it serves?

A. I never read the charter of the Cullman County Corporation.

By Mr. R. T. Jackson:

Q. A monopoly in fact; you know what I mean by that?

A. I didn't know that anyone had a monopoly on a territory.

Q. You don't understand what I mean by a monopoly in fact of an electric company serving an area?

A. My understanding is the sole right to serve is what you mean. I may be mistaken.

Q. Let me ask this question, and I will try to get a word that will not confuse you. May I inquire whether the Cullman County Electric Membership Corporation is the only organization offering electricity for sale in the area in which it serves?

A. There are other lines in the county.

By Mr. R. T. Jackson:

Q. Offering electricity for sale on the highways where the Cullman County Electric Membership Corporation offers service?

A. There are other lines in Cullman County.

Q. That is not the question. You understand the question, Mr. Witness? Now, are you willing to testify that there are any other organizations of any kind offering electricity for sale to the residents along the highways where the Cullman County Electric Membership Corporation has its lines constructed and is now offering electric service?

A. I would have to refer to the map to clear up my mind on that, but there may be such a situation there.

Q. Can you name one?

A. I should want to refer to a map to refresh my memory on that particular situation. I don't remember all these details.

Q. Can you name one now? You can say yes or no.

A. Offhand I could not name one without refreshing my memory."

[fol. 1637] I accept the information contained on Complainants' Exhibit 919 of the Tennessee Valley Authority's Division of Electricity as being trustworthy and reliable.

According to Complainants' Exhibit 919, the number of domestic customers served by the Cullman County Electric Membership Corporation as of August, 1937, was 891 and the number of commercial customers was 104, a total of 995 customers for the month of August, 1937. The last sheet on Complainants' Exhibit 919 shows that there were 162 miles of line. That is a little over approximately six customers per mile. As to whether it is true that at that time

there were 44 per cent of the houses or somewhere around 750 along these lines that were not taking service, I don't remember that figure and haven't it with me. It is true that Complainants' Exhibit 919 shows that the total purchases of electricity by Cullman County for the month of August was 56,100 kilowatt hours, which figure would be greater than the total sales to customers. As to whether the kilowatt hour sales by the cooperative per mile of line per month were approximately 272 kilowatt hours, the only figure I could give for the kilowatt hour would be around 500 and I would have to write that down perhaps 15 or 20 per cent to get the sales. I did not actually compute that 500, but I merely estimated it from the miles of line in this other sheet divided into 56,100 kilowatt hours. It is merely a matter of arithmetical calculation, and it would be slightly less than the 662 kilowatt hours per mile of line per month provided by the TVA plan shown on Complainants' Exhibit 918. It is comparable to that figure. I know nothing about whether this project was approved with very much less than the minimum demand specified in the TVA Neighborhood Plan. The approval of such projects is not a function of our division but is a matter of the executive. The TVA acquired about 212 miles of rural lines from the Alabama Power [fol. 1638] Company. The total miles of line in the Alabama Power district, according to the stipulation described this morning, is 314 miles.

On Defendants' Exhibit 136-B is shown in green the lines which were purchased under the contract of January 4, 1934 and sold to the City of Athens. There was a total of 137 miles in the area, 70 miles was purchased and resold and some 67 miles of the lines were constructed by the TVA. All the rural lines which are shown in green, aside from those which were purchased under the January 4th contract, were constructed by the TVA. It is not a fact that all of these rural lines shown on the map, except those that were purchased from the Alabama Power Company under the contract of January 4th, were financed by the TVA. 292 miles of lines were constructed by municipalities on their own. The number of miles of lines financed and constructed by TVA and sold was 1,000 miles.

Defendants' Exhibit 137, entitled "Lines and sub-stations purchased or optioned by the TVA under the contract of January 4, 1934, from C. & S. Companies", does not show projected lines for which requests have been made for ap-

appropriations, but shows only the lines that were under construction and which were authorized for construction by the Board of Directors of TVA, and they are the only lines shown on this exhibit other than those already constructed.

Any plans for the construction of a transmission line to serve electricity to Tarrant City and Bessemer are under another division. I do not know what plans have been made on that. Complainants' Exhibit 484 shows a loan and grant agreement between the PWA and Middlesboro, Kentucky, which is somewhere north of Norris Dam, for the construction of a municipal distribution system to distribute TVA power. Our division has not been authorized to lay out the transmission line to carry power to that point, but I would like to state that this map is not intended to cover anything but transmission lines constructed or under construction.

[fol. 1639] To my knowledge our division of TVA has not been authorized to make any surveys or designs for construction of transmission lines to the towns of Newbern in Obion County, Tennessee, Paris in Henry County, Tennessee, Clarksville in Montgomery County, Tennessee, Lewisburg in Marshall County, Tennessee, Lenoir City in Monroe County, Tennessee, Aberdeen in Monroe County, Mississippi, or Starkville in Oktibbeha County, Mississippi, shown on Complainants' Exhibit 484 as towns where the PWA has made loans and grants for the construction of municipal distribution systems to serve TVA power. The engineers in our division would make the field surveys for such transmission lines and we have not been authorized to make any surveys. The plans of extension do not come under our division but come under the planning division. I am in the design and construction, department of operation.

In the Hearings on the Second Deficiency Appropriation Bill for 1937 on page 359, it appears that there were 1049 employees in the Department of Electricity. That was the former name of the Department of which my division was a part. Down at the bottom of the page there is shown the engineering, planning and design division, with 1030 employees. That is not my department. I am in the department of design and construction, Department of Operations. It is a part of the old Department of Electricity and there was a reorganization last summer which eliminated the Department of Electricity as such and the name now is the Department of Operation.

The TVA is not now constructing or about to commence construction of electric transmission or rural distribution lines in the State of Mississippi to be subsequently operated by the Four County Cooperative Association. I do not recognize any such name as the Tippah County Electric Membership Corporation. To my knowledge, there is no such corporation. It may be a recent organization and I don't know whether the TVA is constructing any lines for it. [fol. 1640] I was present at some conferences in July of 1937 with the city officials of Columbus, Starkville, Aberdeen and West Point concerning the construction of electric lines in or about those municipalities, but I had no particular discussion, as I remember it, with those gentlemen with regard to the construction of lines. I do not know whether that took place before there was any application by any of these towns for a contract for TVA power. I do not know the status of the application. I was present at that meeting in July of this year. In the affidavit filed in this case on the hearing for a preliminary injunction by Mr. Woodruff, who is my immediate superior, he states:

"It is stated that announcement was made of a high transmission line from Okolona and Starkville. There have been numerous discussions with regard to transmission lines in this area."

There were such discussions and I think it is further explained by the statement that follows the one you read:

"However, no project has been definitely worked out or prepared for approval, and no engineering work has actually been done on this project other than making very rough estimates of approximate costs and discussion of the projects involved."

As to whether these rough estimates and discussions were had with officials before any applications were made, I had no such discussions.

I testified that we had not been authorized to make any surveys or designs for a transmission line up to Middlesboro, Kentucky. I do not know that it is a fact that it was announced in the LaFollette Press for December 27th that requests for routing the lines through that city had been rejected and the TVA was projecting a line by way of Maynardsville to Middlesboro. I have never read the LaFollette

[fol. 1641] Press and I could not testify about that. Our department would not be authorized to give out any such release and our department did not give it out.

Referring to Defendants' Exhibit 138, entitled "Transmission Facilities of TVA and of Private Utilities", the lines of the Duke Power Company are about 100 miles from Watts Bar Dam. The lines of the Duke Power Company would be naturally closer to Hiwassee and Fontana Dams. They would be on the order of 60 or 70 miles from Hiwassee Dam and about the same distance from Fontana Dam site. The distribution systems of Louisville and St. Louis would be something on the order of 150 miles from Gilbertsville Dam, but I do not have the exact figure. Louisville would be about 200 or 250 miles from Pickwick Landing Dam.

TVA had constructed, as of October 15, 1937, about 3,600 miles of all types of distribution and transmission lines, including the rural lines which it has constructed for municipalities or in the ceded areas, and including about 1300 miles of line which TVA has constructed for cooperatives or municipalities under contract. As to whether TVA built 65 miles of 154 kv. line from Wheeler to Columbia in 70 days, I don't remember how long it took TVA to build that line. I should say that was going pretty good speed if they built it in 70 days. As to whether that is in accord with the fact, I don't remember exactly how long it took to build that line and I haven't that figure with me. I was in the Department of Construction at that time, but I can not remember all those details. As to whether it is true that that project could have been duplicated elsewhere by TVA, if we had two construction crews, one could work on one project and one on another. It is regular practice among the companies to have several construction crews which would be constructing different lines or different sections of line of that or [fol. 1642] other character at the same time. If sufficient crews were available, it naturally would be possible to build lines much more rapidly than at the rate of 300 or 400 miles a year. Generally speaking, one can multiply the crews and increase the construction in a year, but they may come up against a limitation on the purchase and delivery of material. I do not mean a shortage of steel and wire, concrete and cement, but rather an inability to obtain from the manufacturers, due to the condition of the factories. There are occasional difficulties even now. I can not testify as to

whether the steel, wire and cement factories are overloaded now or not.

“Q. Mr. Hapgood, was I right in understanding you to testify this morning that one of the purposes of what you call inter-tie lines, and which I understood to be lines connecting the different dams and generating plants, was to increase the firm capacity of the system, or dams?

Mr. Fitts: Just a moment. I object to the question because it misstates the testimony of this witness and I think quite material testimony of the witness, which was with respect to the functions performed and not the purposes for which the lines were constructed. I think it is materially different. If the question is reframed in accordance with his testimony as to what function the lines performed, as distinguished—

Mr. R. T. Jackson: I think that is an improper objection. I am only asking the witness am I right in my understanding of his testimony, to be a certain way.

Judge Allen: Objection sustained.

Mr. R. T. Jackson: May we have our exception, please?

Judge Allen: You may have your exception.”

I testified that the inter-tie lines between the dams and generating plants served the function of permitting an interchange of power between the various dams. That connection has a tendency to increase the firm capacity of the system, since you can transport power from one dam to the other. I know from my experience that it would increase the firm capacity.

[fol. 1643] The existing utilities serve the City of Chattanooga and have been for some time past, with several transmission lines. As to whether there are four or five such lines, I do not remember the exact number. I have not investigated and can not say offhand that any two of these transmission lines are adequate to serve the requirements of Chattanooga. If lines should be constructed by TVA adequate to serve the City of Chattanooga and service were offered in Chattanooga over those transmission lines, those transmission lines might possibly be a duplication of the facilities of the utilities including their transmission lines into Chattanooga to serve that city, depending upon the

arrangements that are made and the connections that are made.

Examination by the Court:

"Judge Gore: I have been thinking this morning, since you defined, or gave the definition of duplication, I have been wondering what you mean by it. You say there are some lines three or four, Mr. Jackson says in his question, now coming into Chattanooga and serving Chattanooga. Then he asked the question if the TVA should erect transmission lines into Chattanooga, would that be a duplication. You say it would not. Now, how is it possible for it not to be, is what has been worrying me all morning.

The Witness: Let me first explain my definition this morning of duplication.

There are two meanings of duplication: First, in which the facilities are supplementary, such as these lines, two, three or four lines whatever it may be, serving the city, one assisting the other so one line may be out of service and still the service maintained adequately and properly.

The other meaning of duplication is a facility to fulfill a function which is already adequately served. My statement that it might or might not be a duplication is based on the thought that these facilities which Mr. Jackson mentioned could be tied into the existing facilities, thereby providing additional support, providing suitable agreements were made.

Now, if the suitable agreements were not made, of course, that would be a duplication in the last sense.

[fol. 1644] Judge Gore: I get your answer, to Mr. Jackson's question that sufficient lines were coming into Chattanooga to supply the demand now. Of course, I also get the idea, the impression, that TVA was not going to tie onto the present system, but they were going to build their lines into Chattanooga independent of what is already here. Then would that be a duplication? Would that be a substitution, or what would that be?

The Witness: So far as I know, the Authority is not going to construct any lines into this city.

Judge Gore: I do not know, but suppose they did.

The Witness: If the lines were constructed from Chickamauga Dam to Chattanooga to serve the same load as

being served now, as two separate systems, there would be a duplication to that extent.

Judge Gore: Well, that is what I thought."

Cross-examination continued:

Assuming that there are five major transmission lines supplying Chattanooga and that any two of the five are sufficient to supply the requirements of Chattanooga, the construction of additional transmission lines into Chattanooga to serve that system would to that extent constitute a duplication. If the load is adequately served, it is certainly a duplication to the extent that additional facilities are built. However, there must be some duplication now if two lines are serving the city and there are five around the city.

It is true that private utilities have been serving the Memphis area for some time. As to whether there would be a duplication of service if TVA constructs facilities into Memphis to serve the entire load of the city, the TVA line to Memphis is not a duplication of any existing facilities. The City's distribution system may duplicate the existing system. As I pointed out, there is a shortage of power in that area, even with the amount of power from the new contract to supply the Arkansas Power & Light Co., and [fol. 1645] therefore that line will not be a duplication. Assuming that a private utility has an existing supply of power adequate to serve the requirements of the City of Memphis and the TVA substitutes a completely new supply of TVA power in lieu of the supply from the existing facilities, that line is not a duplication. If there is any duplication there, it consists in the internal distribution system being duplicated. Certainly in an area that is deficient in power, an additional transmission facility coming into that area is not a duplication of any facility.

"Judge Allen: Is a PWA loan involved in the Memphis situation?

Mr. R. T. Jackson: A gift, your Honor, \$4,000,000.

Judge Allen: With reference to this matter of gift, should we have the Alabama Power Company versus Ickes case argued before us?

Mr. R. T. Jackson: It has not been my thought that it would be.

Judge Allen: I thought that the Supreme Court pointed out in certain cases, grants of 30 per cent to any municipality, and in certain cases grants of 45 per cent were made, and held you could make them.

Mr. R. T. Jackson: So far as the PWA Act is concerned, that is true.

Judge Allen: Yes.

Mr. R. T. Jackson: I have asked nothing about the gift to Memphis.

Judge Allen: I have been wondering whether in view of that position we can—really the Court is bound by that decision and the attorneys are officers of the Court and of the Supreme Court, they are bound by it, and the Court has been wondering as to the materiality of the questions involving these municipalities in situations governed by that decision.

Mr. R. T. Jackson: As I stated the other day, the decision in the Alabama case turned upon the right to sue. I did not understand it affects our right to proceed here.

Judge Allen: It turned upon this point, that the curtailment or the destruction of the business of the utility by that kind of competition did not invade its legal right.

[fol. 1646] Mr. R. T. Jackson: I did not understand that it did. I do not know that the Court is asking to have the point argued at this time. I presume we will ultimately argue the question to the Court.

Judge Allen: The Court has considered the matter, and they feel as though that decision should somewhat narrow the scope of this controversy.

Mr. R. T. Jackson: We would like to be heard before the Court renders a decision on the basis of the Alabama Power Company versus Ickes.

Judge Allen: We had hoped that it might help out in the situation this afternoon.

Mr. R. T. Jackson: The only way that I can see that it would help out, your Honor, would be by an assumption that some material part of our case was, before argument and final submission, decided against us. I make no such assumption, therefore, I desire to make my record upon what I believe to be the law.

Judge Martin: Yes, but the Court bases its action upon what it conceives to be the rules of evidence, and that after all, is a question for the court.

Mr. R. T. Jackson: Quite so. And if the Court feels that our case is narrowed and rules out our evidence, we should like to make our record, because, unfortunately, we do not share that view, and wish to make our record as we see it.

Judge Allen: And of course, the Court, no more than the river, operates in vacuo. We are aware of the decision of the Supreme Court in the case of the Alabama Power Company versus Ickes.

Mr. R. T. Jackson: I appreciate that, and only earnestly hope the Court will keep an open mind until we have had an opportunity to present our views.

Judge Allen: My mind is closed on that case, because the Supreme Court is superior to me, and the superior court of the land has spoken.

Mr. R. T. Jackson: Of course, we are not in any way arguing the Alabama Power versus Ickes case, but putting in evidence, and I have never known that the question of the application of a decision of the Supreme Court is, under an entirely different state of facts as here, *res adjudicata* to that decision, and we should like to be heard on it before decision. I know of no way of doing that except by going forward and making the record.

[fol. 1647] Judge Allen: Very well, proceed. But I never knew a Court with a sense of its duties ignoring the decision of the Supreme Court of the United States upon a question involving some of the very same questions raised by the pleadings before the Court.

Mr. R. T. Jackson: The unfortunate thing, your Honor, I do not so construe the decision and pleadings. That is another thing I want to be heard on. Of course, the Court is not going to ignore any decision of the Supreme Court, neither are we, but I want to argue what application it has here, if any, and we do not think the application here is adverse to us."

Referring to Defendants' Exhibits 137 and 138, as far as I know the transmission lines of TVA in so far as they have been constructed, have not been built in many instances close to towns served by existing utilities, so that they would constitute duplicate sources of service for those towns. As an illustration of that, the Wheeler-Norris line misses every large town on the way between Wheeler and Norris Dams. As to whether they are pretty well designed

or located to serve the cities served by existing utilities, coming close to the cities, all through that area, other lines that I have mentioned do come close to towns. These transmission lines have been built to serve contracts, and with that in mind, we would serve the contracts we had. The Wilson-Norris line was not built to serve the Aluminum Company's contract. It was built as a tie-line and was so classified. It was built before the contract with the Aluminum Company was made.

"Q. Did the Tennessee Valley Authority employ Jackson and Moreland in 1934 as consultant engineers to study the requirements and characteristics of the proposed TVA transmission system, in cooperation with private utilities?

Mr. Fitts: We object to that question, may it please the Court, as it refers to a matter completely in the past, has no relation at all with this case. The question—

Judge Allen: Objection sustained. You may have your exception.

Mr. R. T. Jackson: An exception, please."

[fol. 1648] Colbert, Franklin, Lauderdale, Lawrence, Limestone and Morgan Counties are located in the so-called ceded area in Alabama.

The table (offered and received in evidence as Complainants' Exhibit 920) being a table of data taken from the official publication by the United States Census Bureau for 1935, shows the United States census for 1935 in Alabama and gives statistics by counties. Assuming those figures are correctly taken from the official report, the average value per farm as shown by this exhibit in the ceded area in Alabama is nearly $1\frac{1}{2}$ times as great as the average value per farm for the entire state, and the average value of farms per acre in the ceded area is approximately $1\frac{1}{2}$ times the average value of farms throughout the state, \$28.18 as against \$18.75.

The list on Complainants' Exhibit 919, being statistics of TVA, under municipalities in the third column shows Athens, Alabama, having 119 miles of rural lines; Lauderdale, Alabama, with 150 miles of rural lines; Colbert County with 135 miles of rural lines; and the Alabama Power District with 96 miles of rural lines; and it adds up to substantially 500 miles. In the fourth column headed Initial Serv-

ice, it is shown that such service began for Athens on June 1, 1934; for Lauderdale County, October 20, 1934; for Colbert County, December 4, 1934; and for the Alabama Power District, May 1, 1936. The stipulation shows the lines which were purchased in these various sections under the contract of January 4th, including the Athens rural lines, and shows 60 miles of lines purchased and 254 miles constructed by TVA. According to the stipulation, there were some 70 miles of line purchased and approximately 67 miles constructed. I would not know it is a fact that more [fol. 1649] than 100 miles were constructed by CWA funds in this county. I am taking my figures from the stipulation sheet which shows the lines constructed.

The second sheet of Complainants' Exhibit 919 shows the number of customers and shows Athens with 1261, of which 22 per cent is farm customers. The figures for the Alabama Power District show that there were 734 customers, of which 47 per cent were farms; Colbert County with 54 per cent of farms; and Lauderdale County with 905 customers, of which 42 per cent were farms. Out of a total number of customers served of 2515, approximately 1153 are rural customers, if that is what it adds up to, but I cannot add that mentally as fast as that. Assuming that the figures are correctly transcribed on Complainants' Exhibit 920 from the U. S. Farm Bureau Census for 1935, it would show that the census for 1935 stated that there were 25,795 farms in all of the counties of the ceded area, after excluding one half of the farms in Franklin County. If those figures are correctly transcribed, less than $4\frac{1}{2}$ per cent of the farms in the ceded area are now obtaining TVA power. I previously testified that in 1936 the average for the state of Alabama as a whole was that 5.5 per cent of the total number of farms were electrified, and in 1935, 4.4 per cent of the total farms in Alabama were electrified.

In the Hearings before the Subcommittee of the Committee on Appropriations, House of Representatives, 75th Congress, 2nd Session, on the Independent Offices Appropriation Bill for 1939, (which appears in the record as Defendants' Exhibit 153) and particularly the TVA application for appropriations on page 1,000, there is given a tentative estimate of possible TVA system requirements and capacity available by fiscal years, 1938 to 1942, inclusive. The figures show that out of the estimated requirements for 1942 only

17,000 kilowatts will be used for rural consumers, which [fol. 1650] is 3 per cent of the total estimated system requirement, and that the municipal contracts now served are estimated to constitute only 3.3 per cent of the total estimated system requirement in 1942. It shows an estimated increase in the municipal contractors' requirements which is on the order of $7\frac{1}{2}$ per cent a year. It further shows that 22.3 per cent of the total estimated system requirements in 1942 will be in connection with municipal contractors which are not now served by TVA, and that their requirements will be 129,000 kilowatts, and that all of this increase is to come from Chattanooga, Decatur, Knoxville, Memphis and Russellville. The distribution systems of all of these cities are now being served by the complainants. Otherwise than in Decatur, both the distribution systems and the wholesale supply of electricity are being furnished by the complainants.

It further shows that the estimate of 20,000 kilowatts for TVA construction in 1938 is continued at the same figure through 1942 and there is no drop-off in the amount of power which is shown will be used by TVA for construction. It also shows that 16.2 per cent of firm power and 12.3 of secondary power of the total estimated system requirements in 1942 will be for industrial contractors. The total in 1942 of 28.5 per cent of the estimated system requirements for industrial contractors compares with the 3 per cent estimate for cooperatives in 1942. I do not know whether the estimate shown on the table for utility contractors given in 1939 and continuing through 1942 is confined to the Arkansas Power & Light Company. This is the first time I have ever seen these tables. I had nothing to do with their preparation and I know nothing about their make-up. On page 1000 of the reports of this hearing, the figure as shown for the 1942 minimum capacity required by TVA customers is 638,000 kilowatts and the figures show that in 1940 the [fol. 1651] surplus or margin over and above the estimated minimum requirements would only be 7,000 kilowatts. I don't know what they mean by that and I had nothing to do with it. The figures are there and I don't know a thing about the make-up of the figures, and I don't know what that margin of 7,000 kilowatts means.

The table (offered and received in evidence as Complainants' Exhibit 921) is the latest figures prepared by Edison

Electrical Institute of June 30, 1937 and is much the same as the table which I used.

Redirect examination:

The customer density of the rural lines of the private utilities which existed prior to the creation of TVA and the cooperatives is greater than the customer density on the new lines in rural territory that have been constructed since the creation of TVA for the cooperatives. As I remember the figures, it is something on the order of 12 customers per mile average on existing lines prior to the cooperatives and on the cooperatives lines the average is something on the order of 4.4 customers per mile. The high customer density on the lines constructed prior to the creation of the cooperatives would be accounted for by the fact that something on the order of 40 per cent of the customers were on the so-called rural lines existing prior to the cooperatives within 6 miles or thereabouts of a transmission substation, and another 40 per cent were living in communities of 100 or greater, and the remaining 11 per cent on the lines lived in communities of 100 or less. It is the creeping out of lines from those load centers or communities which accounts for that.

The Wilson Dam-Norris Dam line is as nearly straight as it is practically possible to make it, considering physical obstructions. It is a straight line between Wheeler Dam and the Watts Bar Dam site, and I believe its nearest point [fol. 1652] to Chattanooga is some 25 miles away. Between the Watts Bar Dam site and Norris Dam the line is as nearly straight as it was physically possible to make it. The line does not go through Chattanooga, Huntsville, Decatur, or through any big city and I would say that it did not go through any good-sized town. Offhand I do not know the size of the biggest town which it goes through, but it would be comparatively small. The line shown as the Chickamauga-Watts Bar line is completed and will serve to connect Chickamauga Dam power plant when it is completed with the Watts Bar Dam site project. The line shown is authorized from Gunterville to the Chickamauga Dam and will likewise connect the two dams.

I do not remember how long the Cullman County Electric-Membership Corporation has been in existence. Complainants' Exhibit 919 shows that Cullman County received its

initial service August 8, 1936, so it has been in existence substantially a year and a half. It is a more or less established fact that there are always possibilities of growth along lines. Initially, it is practically impossible to serve all of the potential customers along a particular line. From an engineering standpoint, the possibilities of growth are as vitally important as the immediate load which may be obtained on construction.

If the generating and transmission facilities of the complainant companies now serving Chattanooga were put in use to serve an increase of load of the interconnected companies at Nashville or elsewhere on the interconnected Commonwealth & Southern system, a new line to the city of Chattanooga by TVA would not be a duplication in the sense that the new line does not displace usefulness of the generating facilities.

[fol. 1653] Recross-examination:

Referring to page 1000 of the Hearings of the Subcommittee of the Committee on Appropriations on the Independent Offices Appropriation Bill for the fiscal year ending 1939, as to whether that does show that TVA expects to obtain the entire load of such load centers as Chattanooga, Knoxville and Memphis by 1942, I could not say that they expected to. I know nothing about the make-up of this table or what was in the mind of the individual that made it up. In the table they do say they are going to take 50,000 kilowatts in Chattanooga, 48,500 kilowatts in Memphis and 25,000 kilowatts in Knoxville by 1942. As to whether that is not the total load, by 1942 I doubt if that will be the total load.

(The witness was excused.)

[fol. 1654] G. O. WESSENAUER was called as a witness on behalf of the defendants and, having been first duly sworn, was examined and testified as follows:

Direct examination:

I am 31 years old and reside in Knoxville, Tennessee. I am a civil engineer. I was graduated from the Carnegie Institute of Technology, receiving the degree of Bachelor of

Science in Civil Engineering in 1927. I was a part time instructor in the engineering college of Carnegie Institute of Technology from 1926 to 1935. After graduation in 1927 I was employed by the West Virginia Power and Transmission Company. My duties there were concerned with preliminary investigations of various hydro-electric possibilities to determine the available power and the cost of the developments. We prepared drawings in connection with applications to federal and state commissions for a number of these developments, and also planned and outlined the work for the various field corps obtaining physical data in connection with such applications. The plans contemplated the integrated operations of some twelve hydro-developments, having a proposed installed capacity of about a half million kilowatts, and they planned to develop most of the potential power of the stream.

About the middle of 1931 I was transferred to the office of the chief engineer of the West-Penn Electric Company. My duties here consisted in making economic studies of the various hydroelectric possibilities as compared with possible central steam stations, as a source of supply for a large utility system. I also assisted in investigations of the possibility of inter-connection with a neighboring utility to reduce costs of generation, and to improve reliability of service. I made an analytical study of statistical data to determine the energy consumption of six major electrical [fol. 1655] appliances. I also gathered and prepared data, including extensive studies of the hydro-electric power resources in connection with a report to the National Power Survey. There were five large river systems, including some 46 developments, having a proposed installed capacity of about a million kilowatts. I also made a study and investigation of the economical loading of distribution transformers.

I am an associate member of the American Society of Civil Engineers. I was a co-author of a paper entitled "Application of Duration Curves to Hydro-Electric studies," which was published in the transactions of the American Society of Civil Engineers and which received the 1934 Collingwood prize.

I came with the TVA in September, 1935, and was employed in the power section of the Projects Planning Division to make studies of the power that might be available

from the projects of the TVA then under construction or being planned. I am now power supply engineer, having been transferred to that position about last September. My duties in that position are to determine the amount of power that might be available from the projects or from the system under actual operation, with generating capacities either installed or proposed. In my previous position I was called upon to make studies of potential power and of provisions for possible ultimate installations in connection with investigations, preliminary to the authorization of both dam and reservoir projects of the TVA. Since it would be costly, and almost prohibitive, to add capacity to a project which had been built without making provisions for such installations, it was necessary to make these studies to determine what provision should be made for those future possible installations of equipment at a later time in this initial construction time.

[fol. 1656] I have with me a copy of the report on the unified development of the Tennessee River system of March 31, 1936. I was called upon for the estimates set forth in Table 6 appearing on page 62 of that report. Most of these estimates were made as a part of our routine studies, which were made for the purpose of determining what adequate provision should be made for the projects at the time of their initial construction. For those systems in the table which list Fontana, studies were also made to determine the effect of integrated operation with the Aluminum Company's plants on the Little Tennessee River. The Aluminum Company's plants are three: Cheoah, Calderwood and Santeetlah. The Fontana site is just upstream from two of these projects and the release or storage of water from the Fontana project would affect the operation of the Aluminum Company's plants. Therefore, in these studies, integrated operation of the Aluminum Company plants was assumed. To obtain the figures shown in this table we first calculated the power that would be available from all of the plants. Of course, part of this power would belong to the Aluminum Company, so that from the calculated amount there was deducted an arbitrary amount assumed from previous negotiations regarding the Fontana site.

In arriving at the figure of 660,000 kilowatts, which appears in the second column of the table to which I have been referring, there were included the following projects: Gil-

bertsville, Pickwick, Wilson, Wheeler, Gunter'sville, Chickamauga, Watts Bar, Coulter Shoals, Norris, Hiwassee, Fontana, Santeetlah, Cheoah and Calderwood. Eliminating the Fontana Dam and the effect of the integrated operation with the Aluminum Company plants, and using the same assumptions, the potential continuous power would be about 535,000 kilowatts. At the time those studies were made, [fol. 1657] Wilson Dam was the only dam actually constructed and in operation. At the present time, Norris, Wheeler and Wilson Dams are constructed and in operation.

There have been frequent changes in the assumptions upon which the calculations of power estimates have been based. Probably there have not been any assumptions that have not been changed at some time or other. The last major change in assumptions was made about last March, when the flood control section had completed tentative studies on the filling schedules for Norris reservoir. The assumptions as to operating reservoir levels were not prepared either by the power section or by me personally. A number of the other assumptions, such as the efficiency, evaporation, leakage, etc., were prepared in the power section. The assumptions as to reservoir operating levels originated from studies which were constantly being made by the engineers in charge of a particular project or working on a particular project, and by engineers in the flood control and navigation sections. We have reviewed the stream flow records of the Tennessee River and have found that on a conservative basis the flow conditions in a year like 1925 would determine the continuous power from the systems.

In making the estimates contained in the table in the Unified Report to which I have referred, it was assumed that on April 1 the reservoir at Fontana would be at elevation 1659, or about 54 feet below the top of the gates. So far as I know, there have been no further studies with regard to Fontana Dam since that time. It was assumed that Norris reservoir would be on April 1 at elevation 1020, or 14 feet below the top of the gates. Since that time there has been a change in the assumed reservoir level of Norris Dam that has been given to me for the purpose of my studies. Those assumptions came from the studies of the engineers in the [fol. 1658] flood control section, from the water control engineer, Mr. Woodward.

"Q. Now, I will ask you what that change is as given to you?

Mr. R. T. Jackson: We will object to that, because there is no showing that any change was approved by the Board of Directors. The Board did file this document with Congress and approved it, and there is no proof that they approved any change. We object further that if it is—

Judge Allen: The objection is overruled.

Mr. R. T. Jackson: May I add for the further objection that,—and I ask this question as preliminary for it—were these alleged changes or instructions in writing?

The Witness: No, they were not.

Mr. R. T. Jackson: We object.

Judge Allen: The objection is overruled.

Mr. R. T. Jackson: We take an exception if the Court please.

A. The level of Norris reservoir might be as low as elevation 1005 on April 15, or 29 feet below the top of the gates."

In making the estimate which is set forth in the table in the Unified Report which I have referred to, the reservoir at Hiwassee Dam was assumed to be at elevation 1501 on April 1, which was about 27 feet below the top of the gates as then contemplated. Since the time we were instructed to make those studies, there have been changes in the assumptions as to the reservoir levels at Hiwassee Dam that have been given to me.

"Q. Can you tell us what the changes are?

Mr. R. T. Jackson: Just a moment. We object to that for the same reason, that is, that there is no showing that the change was ever approved by the Board.

Judge Allen: The objection is overruled. The Court has repeatedly ruled that the Authority may put in evidence facts relating to the actual operation of these dams by the persons who operate them, and the Court also bears in mind the introduction in evidence of the water control bul- [fol. 1659] letins and the resolution outlining the authority.

Mr. R. T. Jackson: May we have our exception?

Judge Allen: You may have your exception.

Mr. R. T. Jackson: And may the record show that Hiwassee has not been completed, and consequently never has been operated by this witness or any witness.

A. The level of Hiwassee reservoir might be as low as elevation 1465 on April 15, which is 61½ feet below the top of the gates as now contemplated. There has also been a change in the level of the gates."

In making the estimate set forth in the table in the Unified Report to which I have referred, the upper main river reservoirs were assumed to be at minimum flat pool navigation level and the others were slightly higher than the minimum flat pool as of April 1. Since that time, there have been minor changes in assumptions given to me with respect to the operating level of the main river reservoirs.

An estimate was made of the continuous power available from the ten dam system consisting of Gilbertsville, Pickwick, Wilson, Gunter'sville, Wheeler, Chickamauga, Watts Bar, Coulter Shoals, Norris and Hiwassee, upon the basis of the revised assumptions as to reservoir elevations which I have stated. The potential continuous power from that system is about 485,000 kilowatts, but would vary from four to five per cent either above or below that figure, depending for one thing on the actual filling of the reservoirs within assumed tolerances from the filling schedule, and for another thing on the degree of utilization of the available flow.

The chart (offered and received in evidence as Defendants' Exhibit 139) is entitled "Approximate System Operation, dry year like 1925". Its purpose is to show, first, as is [fol. 1660] indicated by the title, approximate system operation in a dry year like 1925. It is illustrative of the estimates and of the way in which they are arrived at.

"Mr. Fitts: We offer in evidence as Defendants' exhibit No. 139 the chart entitled 'Approximate system operation, dry year like 1925'.

Mr. R. T. Jackson: We object to it on the ground that it is misleading because it omits from the system the Fontana Dam, which is not only shown in all of the reports to Congress, but in the schedule of the latest report to Congress.

Judge Allen: Are any of these figures on this exhibit based on Fontana?

The Witness: No, your Honor. This is based and intended to show the operation of the ten dam system. It more illustrates the method of the calculation rather than for any particular calculation.

Mr. Fitts: It states on its face the projects included.

Mr. R. T. Jackson: That is right, and it says, 'system'. It also states it is the system and indicates that there are ten dams only in the system, and for that reason is misleading, because it has been included in all of the reports to Congress and is included in the current one.

Mr. Fitts: I would like to point out that the Court has ruled before, and I think quite correctly, that each side has the right to present its own theory in this case in exhibits.

Complainants were permitted to show a Fontana Dam site, despite the fact that it is our theory that it cannot be included in this litigation, that it is so speculative and remote and contingent that it is clearly non-justiciable under all of the rules of the cases.

But they were allowed to show it, and I think the Court has previously ruled that we should be permitted to show our own theory of the case, which is that under the widest possible rule of justiciability it is only the system that has been actually authorized that can be before the Court.

[fol. 1661] Mr. R. T. Jackson: This states here projects, not only a system, but contains projects included in the system.

Mr. Fitts: That is correct.

Mr. R. T. Jackson: And thereby is misleading.

Mr. Fitts: This is our theory of the case.

Mr. R. T. Jackson: May I finish my statement? It thereby states then that that is all there are. Here we have a report to the Congress right during the course of this very trial including the Fontana project, listed as one of those in the system.

Judge Gore: Isn't Gilbertsville Dam in the same situation as Fontana?

Mr. Fitts: No, your Honor. Congress has again appropriated money for the investigation at Gilbertsville. It has refused to appropriate any money, even for the investigation, at Fontana. Furthermore, land has been purchased at Gilbertsville.

Judge Gore: Nothing whatever has been done at Fontana?

Mr. Fitts: That is correct.

Mr. R. T. Jackson: Oh, well, some preliminary surveys have been made.

Judge Allen: The Court considers that the Authority is entitled to show the work done in operation of the dams

by the men who operate them, and also are entitled to show the work done by employees of the Authority in preparing for dams which are authorized. The Court is fully aware of the Fontana situation. The exhibit is admitted.

Mr. R. T. Jackson: And may we have our exception, please?"

The diagram in the upper left hand corner of the chart shows the gross system power available from these ten projects for each of the 52 weeks of the year. The diagram immediately below shows the average weekly inflow and releases at the Norris project. The one below that is similar for Hiwassee. The charts on the right show the reservoir contents in the reservoirs as it varies throughout the year.

Examination by the Court:

The one at the top is for all of the reservoirs and the ones below are for Norris and Hiwassee, respectively. Norris and Hiwassee are included in the top one and also the main river reservoirs. There is an elevation scale on the right of those two lower diagrams.

Direct examination continued:

First, I would like to point out the power would be available from these projects with the natural flow assuming no use of storage. In the upper left hand corner diagram there is a dashed line which is marked "Power at main river projects from natural flow". That is the power that would be, or might be produced if the flow passes through all of the heads at these various projects. I would like to go next to the Norris diagram, which shows in solid line marked "Inflow".—That represents the natural flow at the Norris Dam site, or which would be the inflow into the Norris reservoir. That, in a way, represents the power that would be available at that project, with no use of storage, except that it is affected by the head through which it would go. That head would be variable, depending upon the level of the reservoir. The heavy line in the lower diagram from Hiwassee similarly indicates to a degree the power that might be available at the Hiwassee project from

natural flow. The effect of the storage in this group of projects is to regulate the flow of the main stream, and make it more uniform throughout the year, which also results in a greater uniformity of the power that would be [fol. 1663] available. I might illustrate it by returning to the diagram on the left, which is entitled "Norris". In the first part of the year, the dotted line which is marked "release", is below the solid line, which is marked "In-flow", indicating that water is being stored in the reservoir. Later on in the summer when the release or dotted line is above the inflow or solid line, it indicates that water is being taken from storage. The contents chart immediately to the right on Norris shows that the reservoir content gradually increases in the Spring months as water is being stored, and then as it is drawn out in the summer months, when the release exceeds the inflow.

Examination by the Court:

It is upwards from January to June 1 or the first of July to about the middle of October, and then decreases.

Direct examination continued:

A similar explanation would apply to the Hiwassee diagram. There is also storage in the main river reservoirs towards the end of the flood season, water can be stored in those reservoirs until about the middle of May. Then, releases would be made for malaria control operations. The releases are the greatest when the natural flow is the least, and consequently, the natural power is the least.

In the upper left hand diagram, everything below the solid horizontal line which is marked "550,000 kilowatts, approximately 470,000 kilowatts net" represents the estimate of continuous power for that particular system. You can notice on this diagram where the solid line jags up above that line, that is the secondary grade of power available. All of the area below the solid line represents the regulated [fol. 1664] power that will be available from all of the projects.

Taking the Norris chart, for instance, the Norris Reservoir is about elevation 970 on January 1st, and gradually fills to about elevation 1009 toward the end of May. This is not a uniform line, because it depends on the flow that is available, and also that it is held down, so as to come within

the allowable variation. After May, the water is drawn from the reservoir, lowering it to a minimum level about the middle of October. The dry season ended about that time in 1925. The dry season may extend in some years into the month of November and the early part of December. The operation, coming down in 1925, the reservoirs came to minimum levels about the middle of October, and then on the resumption of high stream flow the possibility would be to store water against the natural course of dry flow conditions later in the year. That explains why the Norris chart gradually rises until about the end of November, and then the water is drawn from the reservoir in preparation for the flood season. In other words, according to this, we would be storing there in that period of time between about the middle of October and the end of November in anticipation, and then we would go ahead and waste it in order to get rid of it and lower it.

Turning to the upper left hand diagram, it is marked as being 550,000 kilowatts, which is approximately 470,000 kilowatts net. The difference between the gross and the net figure is due to what is known as utilization losses, that is, to cover leakage and evaporation and losses due to flow not reaching the lower projects at exactly the right time, and inability to operate exactly as anticipated, and other possible operating problems. That is continuous power. [fol. 1665] In this case the difference between gross and net is about 15%. Losses such as efficiency loss in the structures and machinery have already been allowed in obtaining the 550,000 kilowatt figure.

The reservoir elevations would not necessarily be exactly alike any two years. It would be a great coincidence if there were any two years exactly alike. There is bound to be variation in the way those operations go. This is a calculation based on past records and is only our estimate as to how it might be operated under such conditions. The system is still developing and it has not been operating under such conditions yet.

The decrease in continuous power from our early estimate would be accompanied by a greater increase in the amount of high grade secondary power available, offsetting to a considerable degree the apparent economic loss from reduction of the continuous power. There is a difference between continuous power and firm power capacity. Con-

tinuous power is the power which would be available 24 hours a day, 365 days a year, or for any period under consideration. Firm power capacity of a plant or system of plants is for any period the maximum demand which that plant or system of plants can be reasonably sure of meeting, considering load characteristics.

The table (offered and received in evidence as Defendants' Exhibit 140) is entitled "Status of Generating Capacity as of December 31, 1937." The information was obtained as to the units in operation from published statements and reports. As to units being installed, it is knowledge from the construction people, and those under contract. The last ones are from the resolution of the Board.

The table (offered and received in evidence as Defendants' Exhibit 141) is entitled "Successive steps of insulation and estimated power capacity."

[fol. 1666] I have not personally, nor to my knowledge has the power section, ever made any computation as to what filling schedule should be followed in order to fill the various reservoirs to so-called normal pool level. I have not personally, nor to my knowledge has the power section, ever issued any orders or instructions as to how the projects of the TVA should be actually operated.

[fol. 1667] Cross-examination:

I am not the head of the power planning department. Dr. Glaeser is. I report directly to him. At the present time, that department reports directly to the general manager. It is my understanding that it is a coordinate department on the same footing as other departments in that respect.

By high grade secondary power I mean power that would be available from 75 to 80 per cent of the time over a number of years. I drew a distinction between continuous power and firm power capacity. The load factor is a part of the difference between those two terms as I use them; it has all of the load characteristics. Assuming that you had 100,000 kilowatts continuous capacity and that the system was operating at a 60% load factor, you would still have to know what generating equipment is installed before you can determine the corresponding figure. Assuming sufficient generating equipment to permit the utilization of all our continuous capacity on a 60% load factor, the firm power capacity with sufficient generating equipment within that

period for which the load factor applies would be about 100,000 divided by 60—I think it is 167,000. I think that probably with the installation for which the space is provided at the TVA stations, possibly they could use it up to 60% load factor. I understand that the 60% annual factor is about the general load factor of large utility systems operated in the southeast.

As to what use is made of the main river storage for power purposes, the use of the main river storage, is principally for regulating the flow and for malaria control operations which could go through the generating equipment that has been provided to produce power. It would certainly go through the generating equipment in so far as we have any use for electricity.

[fol. 1668] “Q. And are the main river plants operated to supply peak loads during the day period, and reduced operation at night during off-peak hours?”

A. Are you speaking of actual operations, or the calculations?

Q. Is there any difference between actual operations and the calculations in that respect?

A. I want to make it clear that we only have a few dams in operation now, and this discussion here today has been with regard to a system of completed projects.”

In my studies some of the main river plants are to be operated to supply peak loads during the day and reduced loads in operation at night during the off-peak periods. As to whether or not any of the main river dams are being operated at the present time so as to supply peak loads during the day and reduced loads during the off-peak period, I am not operating the project. I don't have charge of the operation of the power project. I have nothing to do with them. I am simply an engineer making calculations with regard to such matters as I have testified to, upon data given to me, and I am not an operating man.

Referring to the figure in the upper left hand corner on Defendants' Exhibit 139, it is not quite correct to state that the dotted line shows the continuous power of the dams named in the project operated as run-of-river. The dotted line shows the power from week to week of the main river projects, except Norris and Hiwassee. That is the main river projects only. That is what the power would be on

run-of-river operations without the use of storage. It would not necessarily follow that we would have some pondage to get that particular dotted line. The solid line shows how much that is increased by low water regulation. The increase is from about 170,000 kilowatts to 550,000. Both lines are expressed in terms of gross power and not net power. The figure 470,000 kilowatts is net for regulated power. [fol. 1669] The amount of increase achieved by regulation is from 170,000 to 550,000 kilowatts, from which the figure to obtain the net would have to be applied to both. The 550,000 is reduced to 470,000, so the 170,000 would also be reduced by about 15%. I have reduced each figure about 15% and the difference represents the amount of increase at main river dams and also power at tributary dams. It is plainly marked at the bottom that it is for the main river projects only and the top one is for all projects. I do not have the figure as to how much the power at the main river projects is increased by regulation. I have not made any calculations corresponding to the one shown graphically in the upper left hand corner including Fontana. I do not know what the effect would be of including Fontana.

Referring to the next figure on the left hand side which relates to Norris, the inflow is the actual record of 1925 as published by the United States Geological Survey as to what the flow would be at the Norris site. The release line is a hypothetical amount based on the study. It is a calculation of what it would be if you had flow conditions like 1925 and were operating this system.

There is some discharge of water during January, February, March, April and May. The amount of water stored is the difference between the release line and the dotted line. There is some release by the dotted line. We do not store all the water available.

As to whether, in the course of my studies I did not have to familiarize myself with the methods of operation now in use, the methods of operation now in use were considered, but when you consider that you have so many projects, the operation might be different from what occurs now. I think the projects now in use would be operated on a daily or weekly peak basis but I did not determine that. I don't know how they are operated. I never knew that there was [fol. 1670] any such committee as the hydro-electric committee of the TVA.

I prepared the figures for table No. 6 on page 62 of the Unified Report. I made the figures and supplied the figures to whoever wrote the report. Santeetlah, Cheoah and Calderwood were included in the calculations to arrive at the 660,000 figure, from which an amount was deducted that would belong to the Aluminum Company as part of the integrated operation. About 90,000 kilowatts were deducted. That was not power that would be produced at Fontana. That represents the amount of the total power that would go to the Aluminum Company as their part of the integrated operation. You cannot identify where the power is produced.

The Fontana site is immediately above Cheoah and would control to a considerable degree the water at Cheoah and also Calderwood, so that the releases from Fontana would naturally affect the operation of Cheoah, Calderwood and Santeetlah. Santeetlah is on one of the tributaries, the water from which is discharged into the Cheoah pool. It means that if you change the operation of the two lower plants, the operation of the Santeetlah plant would be changed to conform. I made the calculations and estimated the total potential power, and I was given an assumed amount and took 90,000 kilowatts from that total to give the net figures shown in this table. I did not make any separate calculation as to how much power would be produced at Fontana. I did not make any separate calculation of how much low water regulation applied by Fontana would increase the continuous power capacity or high grade secondary power capacity of the main river projects.

As to whether I mean to testify that in the 660,000 kilowatts of continuous firm power shown on page 62 of Complainants' Exhibit 328 there is included any power produced at Santeetlah, Cheoah or Calderwood, I am trying to make [fol. 1671] clear that you cannot make that fine distinction in regard to where the power is produced. The power was calculated as the total power of all fourteen plants, from which was deducted an amount of 90,000 kilowatts, which was from the negotiations regarding the Fontana Dam site as being that portion belonging to the Aluminum Company. Part of the total power was produced at the Aluminum Company plants. Each week of the year is different as to the amount of power produced at various points and you can't tear that thing apart and identify each part to determine

how much was produced at each plant of the Aluminum Company. Assuming that a private company was developing Fontana other than the Aluminum Company of America, they would determine how much power they could develop in a similar fashion. I do not mean they would have to go into partnership with the Aluminum Company of America to develop the Fontana Dam site, but the amount of power that belongs to each individual is necessarily only attained by negotiation. I think there are some rivers on which there are various water power developments all owned by different interests. I do not think I can answer whether prior to the Federal Water Power Act each interest took whatever power it produced at its own plant as its own.

I did not include the Hales Bar plant in my calculation. As to why I did not treat that the same as the Aluminum Company plants, I mentioned that the figures given were taken from previous studies which had been made. Those studies did not take Hales Bar into account. Those studies were made to determine the amount of power to be produced by TVA plants on the Tennessee River without any computation as far as Hales Bar is concerned, but we could not do that on the Fontna project.

This figure of 660,000 kilowatts represents as I understand it, the power that would be available to the TVA if they constructed the particular plants listed in the table 6 [fol. 1672] on page 62. If I could assume operation for 1925 flows, I could determine the operations and output of Santeetlah, Cheoah and Calderwood operating separately, or I could determine the three of them as a unit. Upon the same assumptions I could also determine how much power would be produced by Fontana operating as a unit with the other TVA dams. I did not do it.

"Q. Can you point out to me anything in table 6 or on page 62 of Exhibit 328 or any other place in 328 where there is anything to suggest to the Congress that the continuous power capacity figures shown in that report do not accurately reflect the estimates of the Authority in that regard?

A. No, there is not. There is nowhere that it does not reflect that that is not the correct estimate.

Q. Have you finished?

A. I want to point out that on Page 105 there is a paragraph relating to existing plants, which points out essen-

tially there must be close coordination between these plants and the Fontana Plant?"

There is no statement in that report of March 31, 1936, to Congress which suggests to Congress or anyone reading the report that there is included in the table or estimate of continuous power, power produced at the Santeetlah, Cheoah and Calderwood plants of the Aluminum Company of America. The table does not show that. It shows the power that would result to the TVA from the construction of those ten plants.

"Q. And neither the table nor anything else in the report shows or indicates that part of the power is to be produced by the plants of the Aluminum Company of America, is that right?"

A. You have been playing around this subject all morning and I tried to point out to you before that that is the net resulting power to the Authority, and the table shows it as such.

Mr. R. T. Jackson: May I have an answer to my question? [fol. 1672a] Mr. Fly: The document speaks for itself.

Judge Allen: The objection is sustained. The witness has answered and given his explanation.

Mr. R. T. Jackson: May I have an exception, if the Court please?

[fol. 1673] Judge Allen: The table is before us.

Mr. R. T. Jackson: Yes, but he is undertaking to give a different statement, as I understand it, than the table, and I want to know on what he bases that.

Mr. Fly: He didn't submit that report anyway. He took assumptions that were given to him, as he testified.

Mr. R. T. Jackson: I see. If his assumptions have nothing to do with the official action of the Authority, then, I think his testimony ought to be stricken.

Mr. Fly: It is shown that they do have."

I did not make the calculations on page 279 of Complainants' Exhibit 115 which shows an estimate of 660,000 kilowatts continuous capacity of the TVA system and 5,780,000,000 kilowatt hours of firm energy. I cannot make the assumption that the 660,000 is the same as the one in the Unified

Report. I did not prepare that particular liquidation estimate. I did not prepare Complainants' Exhibit 909 which is a photostat of the sheet taken from Complainants' Exhibit 116 showing the TVA system demand, generator allocations, firm power capacity, actual and projected to the end of 1940.

Examination by the Court:

As to whether turbines are always at the bottom of the dam, in the modern practice the turbines are below the generators in the power house. That is, the water flows through the intake, through the turbines, which spin around on verticle axis, and then flows out below. The turbines are towards the bottom of the dam.

Redirect examination:

"Mr. Fitts: May it please the Court, I would like permission to interrupt the cross examination for just one moment, because of the fact that just prior to the recess the cross examination of the witness was directed to the implication that the Board of Directors of the Authority had not completely reported to Congress all of the complicated facts [fol. 1674] with respect to the original proposed arrangement with respect to the Fontana Dam site. I would like to call the attention of the Court right now, before it is overlooked, to the evidence already in this record, which clearly shows that the whole matter was laid before the Committee on Appropriations at the time that the question of the appropriations for the Fontana Dam were under consideration by the Committee in the House. I refer to Complainants' Exhibit No. 115, which is the report of the hearings on the First Deficiency Appropriation Bills for 1936, and I refer specifically, while there are other passages throughout the hearings that relate to the subject, I refer specifically to the passage on page 192, which begins under the title 'Acquisition of Fontana Dam, of the Aluminum Company'.

I would like permission of the Court simply to read at this time a paragraph there in order to get this matter in its proper setting.

Mr. R. T. Jackson: If the Court please, I object to it, as not being a proper interruption of cross examination. There are a great many things about Fontana Dam in the record that we want to call to the attention of the Court also.

Judge Allen: The Court thinks that it is proper for Mr. Fitts to read the paragraph:

Mr. R. T. Jackson: We except.

Mr. Fitts: 'Mr. Taber. Now, Doctor, why should the Government buy the Fontana lay-out from the Aluminum Company of America? It is a purely power development; it is not a navigation proposition, is it?'

Dr. A. E. Morgan: We would not put any power plant in there at present. We would use it entirely for storage providing benefits to flood control, navigation, and power, but especially flood control.

Mr. Taber: Why not let the Aluminum Company of America go on and build it and put in a plant there and provide industrial activity?

Dr. A. E. Morgan: They are going to provide just such industrial activity. Under the proposed contract we would sell them power. But if they build that plant, then they will operate it for the Aluminum Company of America. Here is the best site on any of the tributaries of the Tennessee after Norris, and if we lose control of that, then they will operate it to suit themselves for power only. Also, the difference in value of power that could be generated on the plants down the Tennessee River with unified operation would be about 100,000 horsepower.

[fol. 1675] Mr. Taylor: Why are they willing to sell it on those terms?

Dr. A. E. Morgan: They are willing to sell for two or three reasons. One is that it saves them the investment of that money. They will be buying power through the years instead of building other dams and generating power. They will also get this advantage if that dam is built, in the regulation down the river. They have dams downstream from this; so the water that comes out of this dam would go through their plants down river. They will get a certain advantage. We will get considerably greater advantage than they will. Moreover, if the TVA acquires their property it can supply the Aluminum Company with power from down river dams at once, whereas it would take three or four years for the Aluminum Company to supply itself with power by building the dam.

Mr. Taylor: Are they surrendering their plants down river, too?

Dr. A. E. Morgan: They will operate them so as to obtain the advantages of unified control.'

Mr. R. T. Jackson: There are a great many other provisions dealing with this that I shall not ask the Court to grant me time to read into the record at this moment."

Cross-examination continued:

I did not testify that the capacity of the integrated eleven dam system, without the Aluminum dams, was 535,000 kilowatts. I testified that the potential continuous power of the ten dam system was 535,000 kilowatts under the old assumptions. That is, eliminating Fontana and any question of integration with the Aluminum Company of America plants. As to when the assumptions were given to me upon which my calculations as to capacity were based, I will state that the studies were started about a year and a quarter to a year and a half ago, which were approximately in line with this chart, or these later assumptions. It was not until last March that the flood section had completed their tentative studies on Norris reservoir, and this particular chart has been prepared in the light of the most recent changes of any of those which make some minor changes from those [fol. 1676] earlier studies. The estimates shown on Defendants' Exhibit 141 have to do with firm power capacity, in which case you consider the machinery available, as well as the characteristics of the load and the flow, etc. As to when approximately these assumptions were given to me, I thought I made it clear that these assumptions were being changed from time to time. As to whether my calculations have been made on constantly changing assumptions that were given me during the course of this lawsuit, this lawsuit is pretty long. They were not the result of this lawsuit. For the firm power capacity estimates, the assumptions came about last March. In so far as those assumptions affect my calculations on Defendants' Exhibit 141, they were given to me last March.

In order to produce our firm power, it would be necessary for someone to dispatch the water between the various plants, not necessarily exactly the way I have shown it, to get the same result. In other words, with the number of plants involved, it would be possible to arrive at this result by some alterations from this exact showing here. There would be a margin of variation, but substantially they would have to be in accordance with the assumptions given to me in order to produce the estimates that I have made. It is conceivable that if Mr. Woodward orders some other

type of water control, then my theoretical study might have an entirely different answer. I understand that Mr. Woodward does control the water releases. The result of these calculations, or any calculations, and the nature of any assumptions upon which calculations can be made, depend upon what orders may be given by Mr. Woodward.

I understand Mr. Karr is system operator. As to whether he gets his instructions from someone other than from me as to the method of operation in which he releases water, I am not in that department and cannot testify as to how he [fol. 1677] gets his instructions. He does not get them from me.

Water wheels and turbines are constructed so as to operate at a maximum efficiency for particular heads or ranges. I understand that in designing a plant and installing a water wheel, it is planned so that it will be in operation the greater part of the time within the range of maximum efficiency. As to whether I have been making estimates on that sort of thing, I want to make the distinction. I am not the designer of the water wheels. As to whether I know at what elevation on the reservoir the generators at Norris operate at maximum efficiency, I don't have that with me and I don't know. As to how I could figure the firm power capacity if I did not know that, I had the efficiency curves. Then I did have information as to the range of maximum efficiency of the Norris generators. I am not prepared to answer whether that would be in the vicinity of elevation 1,000 or better without looking at some diagrams. I haven't that particular chart. With regard to efficiency and to the position of the turbines, as to whether it is necessary to hold some dead storage in a reservoir in order to obtain power, if there is no head of water, there will be no power, and if you do not have any dead storage, there would be practically no head.

Examination by the Court:

Dead storage is the space in the reservoir in which the water remains more or less throughout the time of the project. In other words, it is storage below the minimum level to which the reservoir is allowed to go and it is useful for storage of silt and other material like that, as well as for obtaining the head. Possibly some of that water could be used to generate power, which would in turn lower the head further. In other words, the difference between the level of

the lake and the water below the dam is the head. The dead [fol. 1678] storage is the difference in elevation, it would be the head, represented by that dead storage.

Cross-examination continued:

Then there would have to be additional water to flow through the turbines in order to produce any power. Flow and head make power. You can't have it without both. If you simply had dead storage flat without inflow, there would be no power. I think the top of the dead storage at Norris is about 135 feet above the bottom of the river.

The elevations of the main river reservoirs which were assumed in making my calculations on the basis of the so-called changed estimates were at April 1, for Coulter Shoals 805, Watts Bar 736, Chickamauga 675, Guntersville 591, Wheeler 553, Pickwick 412, and Gilbertsville 355. I haven't the elevations as of June 1. I made no assumptions with respect to June 1 particularly. The assumptions were given me that the reservoirs could fill to the following elevations after April 1. That is, Coulter Shoals 810; Watts Bar 740; Chickamauga 682; Guntersville 595; Wheeler 555; Pickwick 413; and Gilbertsville 357.

Referring to the last column of Defendants' Exhibit 141, which says "Estimated firm power capacity, KW", firm power capacity is the maximum demand which that system of plants could be reasonably sure of meeting, considering the load characteristics under the period considered. The machinery available, the continuous power, the load characteristics, all have a part in it. In that calculation there was assumed that the weekly load factor would be somewhere between 60 and 75 per cent. The annual load factor, I think, was something less than 60 per cent. I do not have the figure with me for the continuous power available as comparable to my last column on Defendants' Exhibit 141. I gave [fol. 1679] a figure of continuous power of 485,000 kilowatts for a certain group of these plants. It covered all except Fontana and the Aluminum Company. That was the continuous power on a 100 per cent load factor. That would not be the continuous power figure that would compare with 570,000 of firm capacity, according to my definition on Defendants' Exhibit 141. You cannot divide this firm 100 per cent capacity of 485,000 by plants. I have no such figures divided by plants, nor can you divide it between how much

was run-of-river and how much storage. The way you figure it without knowing any of those things is that you determine the total power available from all the plants under all the conditions that are likely to happen within that period. It is the total of all of them, not individual plants, because there are times when the main river projects could supply the continuous power. In other times of the year, power would be supplied both by the main river projects and by the tributary projects. I studied the characteristics of each plant, such as the head, efficiency of the plant, and flow available. That is all put together in detailed, long drawn out calculations, to get the estimate shown of continuous power. I cannot break it down by plants, because that is not a thing that can be broken down plant by plant. I could supply a break down by weeks.

“Mr. Fly: Do you have that available already?”

The Witness: I haven't it available here, it will take some time to get it.

Mr. Fly: I object to the witness being called upon to make the calculations.

Mr. R. T. Jackson: Haven't you got it in your working papers?

Mr. Fly: The Court has already ruled that cannot be done.

Mr. Fitts: During the testimony of Major Putnam, we made some such inquiry as that, and the Court ruled we [fol. 1679a] could not require the witness to produce detailed working papers for this record.

Mr. Fly: He has not made the calculations.

Mr. R. T. Jackson: May I ask one question to see whether he does have it?

Judge Allen: Now, just a moment, please. The objection is sustained. You may have your exception.”

[fol. 1680] I have made a calculation on the critical month of November, 1925. It is all a part of this total calculation. As to whether I will supply the calculation for November by weeks if I have it in my papers, I haven't that in my papers.

“Judge Allen: The objection is sustained. The Court is not inclined to go into these minutiae. We are required under the statute under which the Court is constituted to expedite this case. Even the Supreme Court is required

to expedite this case. For that reason the Court from time to time has ruled and adheres to its ruling that minutiae will be excluded. In a case where the witness hasn't the papers with him, there is an additional reason. You may have your exception."

Page 62 of Complainants' Exhibit 105 is divided on a system of plants. I mean different systems. The table on Page 1000 of the Hearings on the TVA Appropriation for 1939 (which hearings appear in the record as Defendants' Exhibit 15S) has a line which is marked "minimum reserve." I did not prepare the table but I assume "minimum reserve" means the least amount of reserve. I don't know what it includes as to outage. At the bottom there is a statement "40,000 kilowatts under contract is available." It is not clear from the table what it means and I personally cannot tell what it means.

(The witness was excused.)

[fol. 1681] CHARLES LEE KARR was called as a witness on behalf of the defendants and, having been first duly sworn, was examined and testified as follows:

Direct examination:

I am 45 years of age and reside in Chattanooga. I am superintendent of power operations of the TVA. I have the degree of mechanical engineering from the University of Michigan. I have had approximately 24 years of service or experience in the line of work that I am now following. That consisted of approximately eleven years with the Detroit Edison Company, Detroit, Michigan. Beginning there, I served a student course with the Company, advanced by various stages to technical engineer of all generating stations and of the production department. The last four years with that organization I was assistant chief engineer in full charge of the production department, acting as liaison man between the construction and production departments. It so happens that on this particular property they handled all production design and construction work, all designs having to do with production being approved in the production department prior to being put into effect, and that was one of my duties in that particular position.

From the Detroit Edison Company, I went to the Kansas Gas & Electric Company, Wichita, Kansas, an operating Company connected with the American Power & Light, a subsidiary of the Electric Bond & Share Company, and I was superintendent of power on that operation, in full charge of operation and maintenance, transmission, distribution and generation. I was with that Company for six or seven years, and was transferred to the Carolina Power & Light Company as operating manager. The Carolina Power & Light Company is one of the operating group of the National Power & Light Company, the National Power & Light Company being the subsidiary of the Electric Bond & Share Company. As operating manager of this Company, I was in full charge of operations, in fact, all departments, with the exception of the accounting and legal division. After I left the Carolina Power & Light Company, I was with the Copper Weld Steel Company at Glassport, Pennsylvania, for a short period, as special engineer for those people in conductor installations and designs.

From the Copper Weld Company, I came with the TVA as of March 7, 1936, as superintendent of power operations. I have occupied that position since. My functions as superintendent of power operations are supervision of all generating transmission and distribution facilities. I have charge of the physical operation of the gates at Norris, Wheeler and Wilson dams, and of the amount of water to be released from day to day. I receive my instructions with respect to the amounts of the releases and the rates of release from Sherman Woodward, Chief Water Control Planning Engineer. Those instructions come to me normally in written form and set forth the rates of discharge or release for a given period. In certain instances, instructions are given to me orally. In every instance, I receive my instructions as to the amount of water to be released from Mr. Woodward. No other official or department gives me any instructions on that subject at any time. The organization is so set up that it is necessary for me to follow those instructions. Those instructions are given to me as definite orders and I have not at any time departed from them. I have never been consulted by the Water Control Department or Mr. Woodward or any of these officials in

the formulation of those instructions, with the exception of a very few instances which involved special generator tests or acceptance tests on new equipment. At those times I was consulted to make sure that we had sufficient water to make those tests possible. I normally consult with Mr. N. W. Bowden, assistant to Mr. Woodward in the water control department. I have never recommended to that department or to any official of that department any different water release bulletin than that prepared and issued by Mr. Woodward. No bulletin issued by that department has ever been changed at my request.

In my division, which includes transmission and distribution and generation, there are approximately 300 employees. At the generating stations, we have the customary operating crews headed by the superintendent at each plant. At Wilson Dam, we have a system operation office headed by the chief system operator, who has directly under him load dispatchers, under Mr. C. P. Almon, Jr. My office is in Chattanooga and his office is at Wilson Dam. The load dispatchers come under Mr. Almon direct. They control all operations on the transmission system, granting the right to the various operators at sub-stations and operating stations to carry on switching operations necessitated by constant change of the transmission and distribution system. The load dispatchers are on duty 24 hours a day, and in connection with our operations at the dams, the load dispatchers get hourly reports from the various generating [fol. 1684] points as to the loads, or the energy that has been generated during that hour, the water released during that hour, the pool levels at the end of those hours, and all pertinent switching data which may have been conducted during that hour. They also receive the same information from attended sub-stations. An attended sub-station is one of the primary sub-stations which has attendants there either part or all of the time. The hourly reports are telephoned in to the dispatchers at Wilson Dam and a report for the 24 hour period is mailed to them. The reports are filed at the office of the chief system operator and forwarded by telephone, and forwarded to me each day. To sum up, the generating plants and the attended sub-stations work every hour and report to the Wilson Dam office of the chief system operator conveying the data that I have described. Each 24 hours they submit a written report to that same office and each day I receive from the chief system operator at Wilson

Dam by telephone a summary of all this data, followed by a written report which comes by mail.

In the conduct of the operations of releasing water from the dams, I keep daily records of the daily discharges and of the water used for power. The amounts of those releases are not in any way treated as confidential. You might say the information is broadcast. They are sent to many in the TVA, to certain of the navigation people, and the Army people. We go so far as to send a copy by special messenger each day to Mr. O. J. Miller of The Tennessee Electric Power Company. That data gives the discharges at various points; the river flow at various points; the river stages; the discharge below the dams; and also such pertinent forecast data, which is usually forecast ahead for two or three [fol. 1685] days. That information is compiled by another office. That is water data. It also includes the stages in the various reservoirs.

The tabulation (offered and received in evidence as Defendants' Exhibit 142) shows the water releases at Norris, Wheeler and Wilson dams for the period between June, 1936, through November, 1937. The information was obtained from our plant records and from the water control planning division. For the period shown here from June, 1936, down through November, 1937, this is the complete story of water released at the dams shown. Sheet one is a comparison of the total discharges available for generation by months and totals for the periods ending as of December, 1936, and as of November, 1937. The second column sets forth the total discharges below the dam at Norris in day second feet. We have used a period of day second feet rather than cubic feet per second. Day second feet would be a considerably smaller figure. Day second feet is discharge. One day second foot is equal to the discharge of one cubic foot of water per second for 24 hours. The figures shown here are the aggregate figures for the month on that basis. The second item in the first column, July, 1936, shows a total discharge of 34,790 day second feet. That is the total amount of water discharged for all purposes at Norris. The third column sets forth the estimated discharge available for generation in day second feet, that is the portion of the second column of the total discharge which is available for the generation of power. It is part of the total discharge below the dam which could have been used or passed through the turbines or water wheels if operated to full capacity. At

Norris, under normal head conditions, the capacity of the water wheels in stream flow is approximately 7,800 second feet, I think. The fourth column shows the percentage of [fol. 1686] the discharge available for generation to that of the total discharge. The columns under Wheeler and Wilson dams give similar information for those generating points.

The second sheet attempts to show a comparison of turbine discharges with total discharges and discharges available for generation; that is to say, a comparison of the amount actually used for power generation as compared with the total amount of the releases and as compared with the total releases which were available for the generation of power. The figures are likewise set forth by months. The second column shows the actual turbine discharge at Norris, and the third column shows the percentage of turbine discharge to total discharge. For illustration, in August it shows an actual turbine discharge of 70,250 day second feet. That was the amount actually used for the generation of power. The 78.74 per cent shown in the next column is the percentage of the turbine discharge to that of the total discharge below the dam, as shown on the first page. The fourth column is the percentage of the turbine discharge to discharge available for generation. Looking at the tables for seven months of 1936, they show that the percentage of discharge through the turbines to the total discharge below the dam was 64.07 per cent. The percentage of the total amount which was actually available for generation, and which was actually used for power generated at Norris in those seven months was 79.59 per cent. The comparable figures for the 11 months ending November 30, 1937 are 15.14 per cent of turbine discharge to total discharge, and 22.28 per cent of turbine discharge as compared to the discharge available. The reason why under the heading of Wheeler Dam there is no entry for the first few months down through October on this particular tabulation is that we did not have generation at Wheeler at that time. Wheeler did not begin to generate power until November. [fol. 1687] The third sheet shows the extent of the use of Norris storage for generation at Wilson and Wheeler Dams. The second column under Wheeler Dam shows the Norris reservoir storage releases in day second feet, by months, and totals. The third column shows the Norris storage release used for generation at Wheeler Dam. The next col-

umn shows the percentage of Norris storage releases shown for generation.

"Judge Allen: The Court will suspend in a few moments and it has a ruling to make.

The report on the economic height of Norris Dam by E. Debler, hydraulic engineer, an employee of the Bureau of Reclamation, transmitted to the chief engineer of the Bureau of Reclamation, has been produced by the Authority for inspection by the Court. Complainants desire to inspect it and to offer it as an exhibit in connection with the cross examination of the witness Woodward.

This report was not made to the TVA nor was it made by an employee of the TVA. It does not appear under what direction the investigation was made, nor that the report was required under any Federal statute. The report does not appear to have been adopted or approved by the Bureau of Reclamation. Considered as testimony, it is purely hearsay. Neither does it rise to the dignity of a public document. It has no value as bearing on the credibility of Mr. Woodward, for he stated that the report existed and that it made some such estimate as that described by counsel for complainants.

Since the report as evidence is incompetent, irrelevant and immaterial, it is returned to the Authority, whose property it is.

Mr. R. T. Jackson: If the Court please—

Judge Allen: You may have an exception.

Mr. R. T. Jackson: Yes, but may we not have it made a part of the record, in the excluded portion, so that we may have a review of the questions?

Judge Allen: No, the Court has ruled and you may have your exception.

Mr. R. T. Jackson: May we have a further exception to the denial of the right to have it entered as a part of the excluded record."

[fol. 1688] Examination by the Court:

As to whether the releases of water from the various dams shown on Defendants' Exhibit 142 were in aid of navigation and in the generation of electric power, the releases, according to my instructions, were for navigation and flood control.

“Mr. O'Brian: They were at least in part for power—well, I will pursue that in a moment.”

Direct examination continued:

Sheet No. 3 of Defendants' Exhibit 142 attempts to show the extent of the uses of water released from Norris storage at the Wheeler and Wilson Dams. Column 2 of sheet 3 is intended to show Norris storage used for generation in day second feet at Wheeler Dam. The explanation of the blanks appearing in column 3 is that in the early stages we did not have generation at Wheeler up until November 1936. Thereafter there was sufficient flow in the Tennessee River unregulated to carry on our needs at Wheeler for power generation. All the other releases that were made in that latter period from Norris were not used for generation at Wheeler, because there was sufficient water in the river. The next column shows that part of the Norris storage releases were used for generation at Wheeler Dam. The item 2.72 per cent means there was only 2.72 per cent of the Norris releases used at Wheeler for generation. These same characteristics are also true of the other columns of this exhibit relating to Wilson Dam.

Looking at sheet 2, it shows that 15.14 per cent of the total water released from Norris Dam in 1937 down through November was used at Norris Dam for generation at Norris Dam. During times of high reservoir stages or elevations, the 84 per cent that was released at Norris Dam during that period and not used for generating power at Norris Dam was released by way of sluice gates and spillways, and this [fol. 1689] was done, according to my instructions, primarily for lowering the pool in order to accommodate possible subsequent floods. During latter stages, all discharges were through sluice gates both for navigation and flood control.

Referring to the total of the first column on sheet 3 which shows the total releases from Norris Dam in 1937 for the period specified, none of those releases were used at Wilson Dam for generation. There was sufficient water in the Tennessee River uncontrolled to avoid the use of Norris releases for generation at Wilson. Apart from the 0.76 per cent used at Wheeler for generation, none of the rest of the Norris releases were used at Wheeler for generation of power.

The explanation why the releases from Norris for February of something over 309,000 day second feet, for March of something over 154,000 day second feet, for October of something over 144,000 day second feet and for November of something over 275,000 day second feet are very much larger than for the intervening months shown is because, according to my instructions, during the months of February and March those releases were made for lowering the pool at Norris in preparation for possible subsequent floods. During October and November, the releases were for the purpose of getting the pool lowered for possible floods in the next wet season. According to my figures those releases in the low water periods of 1936 and 1937 substantially increased the minimum stream flow through Wilson Dam during the low water seasons. Definite minimum flows were fixed by instructions from the Water Control Planning Division.

The principal purchaser of power from the TVA during 1936 was the Commonwealth & Southern System. Of the total amount of power sold by the TVA in 1936, 83 per cent [fol. 1690] was purchased by the Commonwealth & Southern System. The reduction in the amount of the releases made from Norris Dam in the low water season on various Sundays and holidays, as testified to by Mr. Woodward, did not result in any reduction in the amount discharged on those days from Wilson Dam below the minimum set for navigation.

I am generally familiar with the power contracts of the TVA. That is a part of my duty. I am also familiar, as a part of my duties, with the generating, transmission and the substation facilities used in serving customers. I know who supplied power to the existing customers of the TVA before the TVA began serving them; and I also know who is now serving customers who were under contract with the TVA but who have not yet begun to take service.

The table (offered and received in evidence as Defendants' Exhibit 143) is a summary of contracts for the disposition of power of the TVA as of December 15, 1937. It is intended to set forth the complete set of contracts now existing between the TVA and its customers. (Counsel for defendants conceded that the exhibit included all contracts regardless of whether service was being rendered under them or not on December 15, 1937.) The information that

goes into the makeup of this exhibit was procured from the information that we keep in my office as part of our duties. The first column of this exhibit on both pages states who the contractors are with the TVA for power, the first category consisting of eighteen municipalities, the second of sixteen cooperatives, the third of eight municipalities who are not yet purchasing power, three cooperatives who are not yet purchasing power, nine industrial customers, three additional industrial customers not yet purchasing power, and one utility. Wherever the statement "Not yet pur-[fol. 1691] chasing" does not exist those customers are purchasing. Wherever the typewritten symbol ordinarily used to designate the word "number" appears on this exhibit, it indicates territories served within the ceded areas in Mississippi and Alabama and described in the January 4th contract.

The contract (offered and received in evidence as Defendants' Exhibit 143-A) is the contract of January 4, 1934, and the contract (offered and received in evidence as Defendants' Exhibit 143-B) is the amendatory contract dated February 13, 1934.

Referring again to Defendants' Exhibit 143, the symbols are explained in the foot-note. I have attempted to show under the heading "Previous service" in the second column of this exhibit where the customers obtained service, or from what point they obtained service, or company in some cases, prior to taking service from TVA. Where the word "none" appears, that is intended to mean that those particular customers were not receiving service prior to TVA service. Jackson, Tennessee, is shown on Defendants' Exhibit 143 for identification in the first column as Item 8, municipal plant, "W. T. P. & Light Co." That means that the power was purchased from the TVA under an early contract for certain municipal purposes. In the later contract it was to sell wholesale to the City of Jackson for their requirements. It is explained by a foot-note. The reference to the cooperatives marked with the letter "X" indicates that there was resale service rendered by the Mississippi Power and Alabama Power Companies prior to the transfer of the property to the TVA under the contract of January 4th. In some of those instances that are marked with the "X", the members of those cooperatives were served directly by those companies prior to the transfer.

[fol. 1692] Those that are marked "X" are all within the ceded area.

Under the heading "Previous service", the legends referring to municipal plants and also municipal distribution systems indicate the source from which they were served. In some instances there were two of three sources and we have tried to show them; also, we have set forth here in some cases, for instance, Athens, Alabama, Dayton, Tennessee, and Tupelo, were receiving service from the Mississippi Power Company or Tennessee Electric Power Company. That is to say, where the legend "Municipal distribution system" is used, it is intended to indicate that the municipality owned its distribution system but purchased its power from one of the utility companies prior to TVA service.

We have attempted to show in the third column under "Point of delivery" as near as possible the point of delivery to these various customers. In the case of the municipalities, we have shown it as the city gate, or substation at the city gate. The last two columns state just what they purport to state, the date of the contract of that particular customer with the TVA and the initial date in the last column when those customers began taking power by purchase from the TVA. The second sheet lists the municipalities, cooperatives and industrials not yet purchasing, and under the heading of "Existing service", the utilities, if any, now serving them. Wherever they had no previous service, the word "none" appears. The next column gives the contemplated points of delivery; the next is the date of the contract; and the next is the date of the initial purchase.

On sheet 1 of Defendants' Exhibit 143 for identification, the words "municipal plant" mean municipal generating [fol. 1693] plant, and it includes primarily both generation and distribution unless it is explained in the foot-note.

"Q. Are these contracts shown on this exhibit, Mr. Karr, all of the contracts which the Authority has for the sale of power?

Mr. R. T. Jackson: You mean today?

Mr. O'Brian: Today.

The Witness: No.

Q. What additional contracts are there not shown here?

A. Well, in the case of Falkville, I think it was the—

Q. Now, wait a minute. I am asking as of today whether it is a complete list?

A. It is."

We have had other contracts with customers who are not shown on this list. For example, we previously had a contract with the Falkville Milling Company that has since been transferred to the Joe Wheeler Corporation at Falkville, Alabama. We also had a contract with the Volunteer Portland Cement Company which has been transferred to the City of Knoxville. However, we never began operations under that contract. We also had a contract with the Western State Hospital, a public institution near Bolivar, and it was transferred to the City of Bolivar. We also had a contract under date of January 4th with the Commonwealth & Southern which has expired. To the best of my knowledge, there was never any contract with the Yates Bleachery, but there were some small temporary contracts with cotton gins, and with certain cooperatives. All those contracts have expired. So that today we have here, to the best of my knowledge, a complete list in this exhibit of all power contracts of every description now in existence with the TVA. That is a complete story.

[fol. 1694] Apart from the question of contracts, the TVA is now serving customers other than those listed on Defendants' Exhibit 143. We are serving some customers direct in the Wilson and Norris Dam areas. Those customers are made up of residential customers on the government reservations and certain rural customers adjacent to the reservations. They are approximately 2,000 in number. None of them are being served under formal contracts. Some of them were taken over by the TVA under the contract of January 4th. The Lincoln County Electric Membership Corporation, which appears as No. 6 on Defendants' Exhibit 143 under the heading of cooperatives, took possession of the distribution facilities and began the purchase of power at wholesale from the TVA on December 11, 1937. Prior to that day, the TVA operated the lines of the Lincoln County Electric Membership Corporation under a special agreement with that corporation.

The contract (offered and received in evidence as Defendants' Exhibit 144) is a contract now in force between the TVA and the Lincoln County Electric Membership Corporation.

There are no operating agreements now in force by which the TVA is operating any properties. However, there have been a few, and they have been terminated. All of the rural properties at any time operated by the TVA have now been disposed of, with the exception of the rural customers in the areas adjacent to Norris and Wilson Dams.

The document (offered and received in evidence as Defendants' Exhibit 145) is a copy of an "Agreement between the Tennessee Valley Authority and the Arkansas Power & Light Company".

The document (offered and received in evidence as Defendants' Exhibit 146) is a copy of "Amendatory agreement between Tennessee Valley Authority and Aluminum [fol. 1695] Company of America," dated January 20, 1937. The TVA rendered electric service to the L. N. Gross Company of Fayetteville, Tennessee, under an operating agreement with the Lincoln County Electric Membership Corporation. The TVA served directly that Company at one time over the rural lines in Lincoln County. That contract was taken over by the Lincoln County Electric Membership Corporation as of December 11, 1937, and that Company is now being served by the lines of the Lincoln County Electric Membership Corporation. The fact is that the L. N. Gross Company had a contract even at that time with the Lincoln County Electric Membership Corporation.

I am in charge of the power houses and transmission lines of the TVA and I know from my records the amount of generation of power at each dam of the TVA and the amount of power delivered to each customer of the TVA. I am familiar with Section 7 of the contract of January 4th.

"Q. I wish to ask you a few questions relating to the service that has been made under that particular section of the contract. Which municipalities did the TVA serve during the contract of January 4, 1934 in the so-called claimed territory of the Alabama Power Company, the Mississippi Power Company and the Tennessee Electric Power Company, outside of the ceded area?"

Mr. R. T. Jackson: I object to the question because the witness has testified that he did not come with the Authority until March 11, 1936, and now he is asked to describe what was done by the Authority under a contract made on January 4, 1934.

Q. These records are kept in your office, are they, Mr. Karr?

A. They are.

Q. Do you know what the records show relative to that service?

A. Yes, sir.

Mr. R. T. Jackson: I object to that question.

[fol. 1696] Judge Allen: He may answer.

Mr. R. T. Jackson: Exception.

A. Okolona and Amory, Mississippi, and Dayton, Pulaski and Dickson, Tennessee.

Q. During the term of that contract, referring to Section 7 of the contract, did the Authority sell any power in the Counties of Rhea, Roane, Meigs, and the Western part of McMinn, Tennessee, or in Monroe County, Mississippi?

Mr. R. T. Jackson: I object on the same ground, I make the same objection.

Judge Allen: The objection is overruled and you may have an exception.

A. Yes.

Q. What other customers, not previously served by those companies did the Authority serve within the so-called ceded territories during the existence of the contract of January 4, 1934?

Mr. R. T. Jackson: I make the same objection.

Judge Allen: All of these contracts are in evidence, are they not, Mr. Jackson?

Mr. R. T. Jackson: All contracts that the Tennessee Valley Authority has made are in evidence. Whether or not those matters are concerned with those contracts I don't know.

Mr. O'Brian: I think they are all in evidence.

Judge Allen: The contracts are in evidence—that was the understanding of the Court in its first ruling, and therefore we feel that the best evidence rule does not apply here. The best evidence is before us, but this witness in whose office these records are kept may summarize to the Court the result of his knowledge, in aid of the Court, and for the convenience of everyone concerned. The best evidence is before us. If there is any question about the facts, the best evidence is here.

Mr. R. T. Jackson: I understand that all the contracts are in, but whether or not they relate to the particular matters about which the witness is now being interrogated, and whether there was service under those contracts, I don't know—I simply don't know.

Judge Allen: You understand that the matters about which you are asking now relate to contracts already filed? [fol. 1697] Mr. O'Brian: That is my understanding.

Judge Allen: And covered by this summary of contracts introduced in evidence?

Mr. O'Brian: Yes, if there is any mistake about that I will straighten it out during the recess. If there is any fault in that I will withdraw the evidence. It is not very important anyway, but it is a matter that should be covered.

Q. What other customers were served under that contract outside the ceded area? Will you refer to your notes and give me that?

A. Yes, sir.

Mr. R. T. Jackson: I should like to have my objection noted on that.

Judge Allen: The ceded area is a matter of geography, isn't it?

Q. And we were permitted to serve customers outside of that area with aggregate load not to exceed 2500 kw.?

A. That is correct.

Judge Allen: The witness may answer."

The list is, the Cullman County, Alabama, Electric Membership Corporation; the Duck River Electric Membership Corporation, Tennessee; Lincoln County Electric Membership Corporation, Tennessee; the Middle-Tennessee Electric Membership Corporation, Tennessee; Pickwick Electric Membership Corporation, Tennessee; and the North Georgia Electric Membership Corporation of Georgia, and a part of the time the Monsanto Chemical Company located near Columbia, Tennessee. The maximum number of kilowatts outside of this contract was 1673 kw. At the date of the expiration of the contract, February 3, 1937, it was 956 kilowatts, exclusive of Monsanto. As of February 1937, Monsanto amounted to 850 kilowatts.

The document (offered and received in evidence as Defendants' Exhibit 147) shows an analysis of power disposi-

[fol. 1698] tion and use by the TVA. The information was compiled from the official records of the TVA. Referring to part 1 of this exhibit, each of the sheets shows a different calendar year beginning with the calendar year 1933 and going down to the calendar year 1937, through the month of October. The first column purports to show a list of the customers served. The expression in the second column "ultimate consumers" means consumers at the end of the year. It is not necessarily the maximum during the year, but those at the end of the twelve months' period. (Counsel for Defendants explained that an ultimate consumer means a consumer served with power, not necessarily by the TVA directly, but served with power generated by the TVA through a contractor; for example, the TVA may have one customer, an operator, but the ultimate customers may run into the hundreds.) Referring to the first column on the second sheet headed "Direct service", and the second category there "Temporary rural", Lauderdale County, Alabama, is shown with the number of ultimate consumers at the end of that year, namely 160. Column two shows the number of customers served at the end of the year that were being served, especially in the case of cooperatives, etc.; and in the case of the municipalities, it sets out the municipalities being served at the end of a given period. The third column is the total of the succeeding columns across the page. The third column, total kilowatt-hours, is broken down by months in the items across the page.

Referring to sheet 9, which is the second sheet of part two, the first column gives the customer and the type. The second column attempts to show the normal source of energy to [fol. 1699] serve these customers, and in some instances where the source can be definitely fixed, we have shown it here, that is at a generating station or from C. & S. Interchange. By C. & S. Interchange we mean that it is taken from a point on our system from the Commonwealth & Southern group, and returned to them possibly at Wilson Dam, or maybe some other source on our system.

By "Method of delivery" in the third column is set out the facilities in this particular case, rather than the city gate or some other location that we indicated on a previous exhibit. Most of these sources or method of delivery are from sources of primary stations to the customer, and the facilities involved. The point of delivery is also shown or we attempt to show there the substations or generating

points involved where they can be tied to it, or in the case of certain of the direct services at the customer's meter. The facilities listed here are not in all cases owned by the TVA. Where they are not owned by the TVA, in certain instances we have shown by the legend that they are owned by the Alabama Power Company. In other instances they are owned by The Tennessee Electric Power Company. Under method of delivery, it shows "A. P. Co.", which means Alabama Power Company. Down below in the third category is "T. E. P. Co.", which means Tennessee Electric Power Company. In cases where those designations do not appear and where the exhibit does not show otherwise, the TVA owns the facilities.

On some of these sheets in part 2, there are double asterisks; for example, in the column "Method of delivery" on sheet 9, we show Mississippi Power Company, and so forth, under temporary rural with a double asterisk. The double asterisk shows the property acquired from the Mississippi Power Company under the contract of January 4, 1934. Referring to Defendants' Exhibit 137, you will note there have been changes in the sources or methods of delivery from year to year. However, the TVA took over certain of the power companies' lines and they showed at one time as being the methods or sources of delivery to the customers. Those lines were these 44 KV lines, or a line through Alabama to Burnsville and Corinth, and from Burnsville to Booneville, Mississippi; and also there were lines from Okolona into Tupelo. They are not shown on the exhibit for later years as the sources. The lines now shown here are being used only for secondary lines or back-up to some extent; that is, since the Commonwealth & Southern interchange was discontinued. I said primary source; there is no generation at Pickwick.

Examination by the Court:

On sheet 9, part 2, there is a similar set of double asterisks after Margerum, Alabama. That was acquired from the Alabama Power Company under contract of January 4th. It is true that the double asterisks apply only to acquisitions from the Mississippi Power Company. Margerum is in Alabama, but that is an interconnection with the Mississippi Power Company.

Direct examination continued:

The single number symbol which I have used in the third column on sheet 12 shows property acquired from the Alabama Power Company under the contract of January 4, 1934. In the other exhibit showing the point of delivery, if it was a municipal operation, the point of delivery would be set at the city gate or substation, which we thought was definitely locating it sufficiently for that purpose. Now we are [fol. 1701] using the substation and facilities, or the facilities that are actually in use for delivery at or near the customer's service. Sheets 6, 7, and 8 under part 1 show the present status of the disposition of power in the year 1937 up to the 31st day of October. Sheets 15, 16 and 17 show, as of the same date, the source of the energy, method of delivery, and the point of delivery.

(Thereupon counsel for defendants offered the analysis in evidence as Defendants' Exhibit 147. Counsel for complainants objected to the introduction of the exhibit in so far as it relied upon evidence that had been the subject of complainants' previous objection which the Court had overruled. The objection was overruled, an exception was noted and the exhibit was received in evidence.)

"Q. My question is intended to relate, Mr. Karr, solely to the subject of secondary power, sales of secondary power. I am asking you with that in mind whether the contracts, the industrial contracts do contain a provision permitting discontinuance in low water season? If there is any doubt about it, I would like to have the complainants produce the contracts. They are in their custody and we can straighten it out.

Judge Allen: The Court thinks that the objection is well taken with reference to any interpretation of the contracts. So far as what the contracts do provide, we think that there ought not to be any question about what is in them, and that counsel ought to be able to tell us what they provide.

Mr. R. T. Jackson: There are none, and I have suggested for the convenience of everyone, and it seems this would permit us to make any correction necessary, if Mr. O'Brian will ask his witness what contracts he claims provide for interruption of secondary power. If that is accurate, when

we look at the contracts, we will raise no question, or if we find it is inaccurate, we will bring it to the attention of the Court.

.

Q. Mr. Karr, will you name the industrial contracts which permit the Authority to discontinue the sale of power, secondary power, in times of low water flow? Can you name those?

[fol. 1701a] Mr. R. T. Jackson: I wish it to be amended to say which the TVA claims.

Mr. O'Brian: Which the TVA claims it is permitted to discontinue."

The contracts with industrial customers which the TVA claims permit the TVA to discontinue sale of secondary power in times of low water flow are the contracts with Monsanto Chemical Company, Victor Chemical Company, Electro Metallurgical Company, and the Aluminum Company of America. In the event of a low water season in which there is not power enough available for all customers, the TVA claims that it is permitted to curtail delivery of secondary power to them. I am familiar with the method of handling commitments of secondary power and this is the customary method. Notice is required by these contracts before interrupting service. Each contract sets forth the method by which the notice should be given. It varies in length in different contracts from 5 to 21 days for the cut-off period. Notice is required to be given to the customer before resuming service. With respect to the purpose of those requirements for giving notice, both as to discontinuing and as to resuming deliveries, the major portion of these customers that I have mentioned have electric furnace operations involved which necessitate when possible a certain cooling down procedure. Further, they require a certain length of notice, or they think it advisable to give their employees a certain amount of notice before a lay-off takes place by such curtailment of power supply.

I don't think that it would be feasible for the TVA to sell this secondary power to municipalities for them to resell to large industrial customers. The reasons why are,

first of all, that you are injecting a third party into this case, which means that notice from us to the municipality and from the municipality to the ultimate consumer must be given. And in the case of disagreement between the ultimate consumer and the municipality, things might become very embarrassing if we found ourselves in a position of cutting off the municipality, and affecting their service in general, in order to meet our curtailments that would be required. Speaking of it in generic terms, secondary power is sold usually to fit the requirements of a customer according to the customer's particular needs. That is almost a custom-made product. The sale of secondary power under these contracts with the large industrial concerns which I have named materially increases TVA's output of energy during the periods that we have such type of power. The full name of Monsanto Chemical Company and the State of incorporation of the party which has been referred to in these exhibits as the Monsanto Chemical Company with whom the TVA made a contract on May 15, 1936, is The Monsanto Chemical Company of Delaware. The TVA has never had a contract with The Monsanto Chemical Company of Alabama.

[fol. 1703] The table (offered and received in evidence as Defendants' Exhibit 148) shows the use of Norris and Wheeler Dams for power supply to Commonwealth & Southern companies, from June through December, 1936. The last seven months of 1936 which are embraced in this exhibit were considered below normal as far as stream flow is concerned. The rainfall condition in that period was somewhat below normal over the entire Tennessee Valley watershed. We consider those seven months normally as the dry months of the year. The table purports to show the sales to the Commonwealth & Southern system over this dry period. The first line on this exhibit shows the net amount of power generated month by month at Wilson Dam. I have attempted to show in the next category the ability of Wilson Dam to generate with and without the use of storage releases from Norris Dam.

The net generation figure on this exhibit in September 1936 for Wilson Dam shows 81,574,275 kilowatt hours. That figure includes water released from Norris. Without Norris releases being used at Wilson, we estimate that we could only have generated 64,432,875 kilowatt hours. The amount of power sold in the month of September 1936 and as shown

by this exhibit to the Commonwealth & Southern companies was 88,520,774 kilowatt hours. To sum up, the sales to the Commonwealth & Southern companies exceeded the total amount generated at Wilson Dam and also exceeded by a large figure the total amount which could have been generated there without the Norris release. The months of August and November show a similar condition. That is to say, in each of these three months the Commonwealth & Southern companies purchased from the TVA a total amount of kilowatt hours substantially in excess of the amount actually generated at Wilson Dam, and an amount [fol. 1704] in a greater excess over what could have been generated if Wilson Dam had been operating without Norris regulation. The tabulations on this table do not show any reference to the use of Wilson Dam power by any other customer of the TVA, nor by the TVA for its own use.

With respect to the source of the power that other customers were buying at the same time from the TVA that these particular sales were being made to the Commonwealth & Southern companies, the deliveries of course came from the transmission system as a whole, but we did set up these figures here on the basis of showing Wilson Dam's ability to furnish all the Commonwealth & Southern requirements and give them first call on the Wilson Dam power. If it had been possible to make an apportionment of what we might call the Wilson Dam allocation to customers other than Commonwealth & Southern companies, it would show up a greater amount as shown on this statement. In my opinion this is a conservative estimate under those circumstances. On the basis of the figures shown, taking those three months for illustration, the Commonwealth & Southern system could not have secured all that power from the TVA in those three months from the Wheeler and Norris Dams, even if they had been sold all the power that Wilson Dam generated. That remaining power came from Norris Dam. That power was not going at that time (1936) to the Aluminum Company. We did not start to serve the Aluminum Company until July 1937. The power went to the Commonwealth & Southern companies.

The table (offered and received in evidence as Defendants' Exhibit 149) shows the hydro-system power data for the calendar years 1926 through 1937. It was prepared from records in my office for the years beginning 1933 at the [fol. 1705] time the TVA took over the operation of Wilson

Dam; and prior to that time from the records of the Army Engineers which they turned over to us upon taking over the operations. Referring to the second column under the heading "Kilowatt hours available", the figures are based upon the stream flows and generating capacities available. That is a computation for each year based on the actual stream flow and the actual generation. The third column sets out the kilowatt hours generated as shown by the record to which I referred. The fourth column is the difference between the kilowatt hours generated and those available, and as far as that column is concerned, the figures there shown represent stream flow which was not used for generation, and so far as power purposes are concerned might be regarded as wasted. The last column is the actual number of kilowatt hours sold.

I previously made the statement that sales of secondary power increased our output for sales to a considerable degree, if we were to make delivery to our customers of secondary power, and further it would tend to actually increase the load factor during these periods.

Cross-examination:

The title to Defendants' Exhibit 149 may be expressed either "Hydro power system data" as it is expressed, or "Hydro system power data". The difference between the second and fourth column on that exhibit may not be wholly explained by station use. The difference between the column headed "generated" and the other headed "sold" is not in substance represented by station use. In this particular case I think it is the station uses plus incidental losses due to transmission.

[fol. 1706] I was formerly with the Carolina Power & Light Company, but I did not have charge primarily of the engineering and construction departments. As to whether my duties were executive, I had supervision over those departments. I was also with the Detroit-Edison and the Kansas Gas & Electric Companies. Those Companies are primarily, if not wholly, steam companies. The major generation is steam. The Detroit-Edison is not all steam. It gets hydro power from the Huron River, Eastern Michigan Division, but they are very small plants.

I am head of the division of operations of TVA, a part of the Department of Operations. We have no electrical

department in the TVA to the best of my knowledge. They abolished the electrical department either in August or September of 1937. My superior is Mr. A. H. Sullivan who reports to Mr. John Blandford, our general manager. I am only part of what was the electrical department and I cannot say whether more than 1,000 men shown by earlier reports to be in the electrical department were laid off when the electrical department was abolished in 1937. To the best of my knowledge, there were none laid off in my division. Some of the men with whom I was affiliated in the electrical department were transferred to other departments with different names than the electrical department. In our supervision of operations, we have districts with district managers and division managers. They are located at various points in Tennessee, Alabama and Mississippi, but not, to the best of my knowledge, in any other states. I want to qualify that by stating that I am being questioned about some members of the Department of Operation that I do not have supervision over. The division managers report directly to Mr. Sullivan. They report to me functionally on transmission and distribution problems.

[fol. 1707] We have district headquarters in our operations. Before the change in name and the reorganization of the electrical department, we did not have division and district headquarters located at places such as Memphis. We have a division office at Memphis at the present time. As to whether those division and district offices in Tennessee, Alabama and Mississippi are engaged in sales promotion, organization and things of that character, I can not testify as to their activities in any promotional work of any kind. They do not report to me in that connection. They only report to me where they are in a district where lines and substations are involved, and where electrical operations are actually being carried on at the present time under my supervision. Those are the only matters they report to me on. As to any other matters, they report to Mr. Sullivan, who is their immediate superior. I know that the division managers have relations with the station officials and officials of the cooperatives where we render service. As to whether they constantly advise with the offices of cooperatives and station officials, I don't know about constantly. I assume that they make many contacts with the customers.

The annual hourly peak demand of the TVA in 1937 was in the order of 137,000 or 138,000 kw. That was the total

demand of both firm and secondary power. I could not give the figure for the maximum one-hour peak demand for firm power for 1937. It would be considerably less. I gave the total demand for the year 1937, which would include secondary power. The peak demand for both firm and secondary power was in December of 1937. I could not say definitely that that is the usual month of peak demand in this area, because I have not made studies of the time of the adjoining [fol. 1708] utilities' peaks, but it is not out of the ordinary to have a peak on a system occur in December. I am not specifically stating whether that is so as to the territory.

As to whether I do not know that our peak firm demand in 1937 did not exceed 75,000 kw., I have not made a study as to what our actual firm demand was in 1937, nor have I made calculations of the firm capacity of the TVA hydro power system at the end of 1937. I have made no comparison of the relation between the firm demand of the TVA hydro power system based on 1937 and the firm power capacity of that system. The first figure in the last column of Defendants' Exhibit 141 shows the estimated firm power capacity to be 258,000 kilowatts. I do not even know the source of that information. I did not have anything to do with it, and do not know anything about it. I have not sufficient familiarity with the system to question its correctness. I have no familiarity with the system whatever in that respect.

If we had maximum firm demand of 75,000 kilowatts and a firm power capacity of 258,000 kilowatts, that would mean that our system was very much underloaded. If we had a system underloaded to that extent, we would not have any trouble as to operation and release of waters involved, because our surplus capacity would be so very much greater than our firm demand. We would not have any trouble in getting sufficient water for generation. It would not require the close, prudent management of water releases and of dispatching which would be required if we had a system that was fully loaded.

I have testified in connection with Defendants' Exhibit 142, which shows total discharges below the dams of Norris, Wheeler and Wilson, and some additional information, that Mr. Woodward gave me instructions with reference to the [fol. 1709] release of water. I said that generally those instructions were in writing. Bulletin 1 and bulletin 2 attached to Defendants' Exhibit 65 are the original instruc-

tions which were used by Mr. Woodward. They are not the only written instructions which I have ever received from Mr. Woodward. I received written instructions from time to time. I could not state how often those written instructions were given to me on the average, but I would answer "frequently". I would not say it averaged once a week, but I think it would average at least once a month. I believe that the bulletins annexed to Defendants' Exhibit 65 were the first bulletins issued, to the best of my knowledge. I had been operating the plants at that time, and since March 7, 1936. However, there were no dams involved, other than Wilson, at that time.

Referring back to the fourth column headed "Kilowatt hours not used" on Defendants' Exhibit 149, there were that many kilowatt hours wasted by way of water because TVA had no market for the power.

Examination by the Court:

Those kilowatt hours were not generated. That is expressed in terms of water that was lost. It is a loss of water, not of actual energy.

Cross-examination continued:

Referring to the column headed "Estimated discharge available for generation" on Defendants' Exhibit 142, that does not mean that none of that ran through the generators. The generation is a part of the available.

[fol. 1710] The third column under the heading "Wheeler Dam" on sheet 1 of Defendants' Exhibit 142 shows the percentage of the total discharge at Wheeler Dam that could have been used by the generators in Wheeler Dam. At the opening of 1937, there was one generator at Wheeler Dam and sometime during 1937 a second generator was put in. If there had been no generators in Wheeler Dam during 1937, we could not have used any of the flow for generating purposes. To the best of my knowledge, the ultimate installation which is now planned at Wheeler Dam is 4 units. Defendants' Exhibit 142 shows a condition at the beginning of 1937 with only one unit and the condition later on in 1937, towards the end, of only two units. I would not say definitely that if there were four units installed there, as is ultimately planned in accordance with the present report to Congress, there could have been twice as much in percent-

age, and absolutely I presume, of water used through the generators at Wheeler Dam. Even if they were the same size generators, it would depend on whether there was enough water at all times to operate. There would not have been enough water, say in August, with 81.81 per cent; and if we had utilized less generating capacity, it would take less water to operate it. There would be a period in the year when there would be insufficient water at Wheeler Dam under the conditions shown on Defendants' Exhibit 142 to operate four generators. Then, of course, there would be flood time in the spring when there would be more than enough to operate even four generators. That is the time when hydro-electric plants produce what is commonly called dump power. That would be purely dump power under those conditions. Ordinarily it is the case that in the construction of hydro-electric plants for public utility service, the practice involves the installation of generating machines [fol. 1711] that will utilize more than the low flow but less than the flood flows of the stream. That would be the situation that would exist at Wheeler Dam when the four generators are installed, if they are installed, under conditions of water flow which I have shown on sheet 1 of Defendants' Exhibit 142.

I have just said that the Wheeler Dam installation at the beginning of 1937 was one-fourth of the designated ultimate installation of the power plant. Later it was one-half. As to whether it is a fact that if Hales Bar, which long ago was completed, had had only half of its generating facilities installed so as to make it in a comparable situation with Wheeler Dam, it would have been capable of using only a smaller percentage of the stream flow shown by me on Defendants' Exhibit 142 than was Wheeler with one-half of its installation, I am not familiar enough with Hales Bar to make that statement, not knowing the exact water conditions at Hales Bar from day to day. I am familiar enough with Hales Bar to think that that is a reasonable statement, provided that there were times when there was more than ample water for generating at Hales Bar at full capacity. As to whether Hales Bar is a typical power operation I have never been at Hales Bar. I couldn't even tell you the capacity installed at Hales Bar. I am aware of the fact that there is a hydro-electric plant there operated by a public utility for the purpose of producing power for sale as a

public utility but I don't know the installed capacity at Hales Bar.

Referring to sheet 3 of Defendants' Exhibit 142, and looking again at Wheeler Dam, I show the percentages of Norris storage releases used for generation and also give a similar figure for Wilson Dam. In 1936 I show no percentage of Norris storage release, used at Wheeler and Wilson Dams. [fol. 1712] That is because the flow otherwise available in the river was more than sufficient to operate the generating capacity to the extent that it was installed and operated in Wheeler Dam during that period. It started in operation in November and we could not use any part of that release prior to that time. The TVA fulfilled all demands that it had for firm power during the period covered by this exhibit. If we had had a larger market for the sale of power, we could have used a greater amount of the releases from Norris for the generation of power to the extent of our generating facilities in order to supply that market as shown in the previous exhibit—that is, if we had had a market for the power. If we had generating capacity installed in our downstream dams sufficient to use the water, we could have used as much, and if possible, all of the releases from Norris for the generation of power to supply that market. Sheet 3 of Defendants' Exhibit 142, showing that very little of Norris Dam releases was made for generation of power at Wheeler, means nothing more than that at that time we did not have sufficient market,—or in one case, any generating facilities,—so that we could utilize that water for the generation of power. When and if the TVA takes from these complainants or others a sufficient market to utilize the releases of water from Norris Dam for the generation of power at down-stream power plants, I would not wish to be understood as testifying that that water would be run through the downstream plants without being utilized to generate power. It would not be if I could help it.

Referring again to sheet 3 of Defendants' Exhibit 142, I have shown in the right-hand side data on Wilson Dam and the percentage of Norris storage release used for generation, and in 1936 I show that approximately 80 per cent on [fol. 1713] the average was utilized at Wilson Dam. When we utilized less than 100 per cent, that was because we did not have enough market or enough generating capacity to utilize the additional water. It is one or the other. The generating capacity installed at Wilson Dam at the present

time is 184,000 kilowatts. I have not seen the reports to Congress and do not know whether there are contemplated increases in that installation up to 640,000 kilowatts. I do not know anything about whether large increases are contemplated.

When I come to 1937 for Wilson Dam, I show zero per cent of Norris releases utilized for the generation of power. That again does not mean anything except that we did not have a market to sell the power that we could have generated at Wilson Dam through the use of Norris releases.

There are reasonable sized blocks of firm power that the TVA is committed to serve under existing contracts and is not yet serving. We hold contracts with Memphis, Chattanooga and Knoxville which will be firm power contracts. I stated the other day that we claimed the right to cut off certain of the power which we were obligated to supply under contracts with certain large industrial corporations. Those contracts also provide or obligate the TVA to supply blocks of firm power. I have no right to cut those off. Those contracts extend for 20 years.

Our contract with the Aluminum Company states that TVA must give 21 days notice of any intention to interrupt secondary power. There is another secondary block of power that only requires 14 days notice. Our contracts with Victor Chemical Works and Electro-Metallurgical Works contain provisions requiring 14 days notice. That means that there is at least one block of secondary power which we could not cut off except on 21 days notice in the case of the Aluminum Company. If we got a bulletin from Mr. [fol. 1714] Woodward telling us to shut off the flow at the power plants of the TVA for flood control or some other reason, we could not carry it out for 21 days. I would consult with Mr. Woodward about what orders should be made in regard to releasing the water in the light of our contract for power and our right to interrupt it. I would attempt to prevail upon Mr. Woodward to arrange the release so that it would keep our contract commitments covered. I would certainly attempt to consult with him.

The contract of the TVA with the Arkansas Power & Light Company contains among other things the following provision:

“Advance Schedule of Loads. Arkansas Company's system operator shall furnish to Authority's system operator

by mail, at intervals of not less than two weeks, a schedule, by days and hours, showing Arkansas Company's expectant use of Authority's service for four weeks ahead, such schedule to be solely for the convenience of Authority's system operator and not to constitute a commitment by Arkansas Company."

When it refers to the convenience of the Authority's system operator, that is Mr. Almon. He is under my direction and jurisdiction. His convenience is in arranging for the production of power in accordance with the requirements of the various demands which the TVA is undertaking to fulfill. In order to do that, Mr. Almon has entire charge of the load dispatchers. He must not necessarily determine where the power must be produced, but he must make sure that the system is so arranged that it will have the power wherever we may have it. He must attempt to be sure that there will be enough power to supply the demands. If the system is fully loaded, that will require a schedule of releases of water at the various hydroelectric plants making up the system; but that has not been the case as yet. That is because we have a very greatly under-[fol. 1715] loaded system, but when we have a fully loaded system, then practical and prudent operations require prudent and careful scheduling of the releases of water from all of the plants available so as to supply the system load curve. This provision looks among other things, to assisting the TVA system operator in scheduling his operations so as to meet the TVA load curve when and as it develops. That will be necessary for us to attempt. We will attempt to get the releases arranged through Mr. Woodward to provide for the scheduling of the releases of water from various hydro plants that are available to the system to supply its demands. There must be water released in some manner or other to provide for the power commitments. In some manner or other it must provide releases which will result in a supply of power that will meet the system load curve.

In the case of a combined steam and hydro system, it is the common practice for the steam plants to be started up during low-water seasons in order to supplement the hydro system. That does not impose quite as severe a problem with reference to water releases as though the system were entirely hydro and on the same water-shed. Provided we begin to run short of water, it is necessary to back it up

with steam. You can use that system generally within certain limits so as to make what might be called a much looser situation for the operation of the hydro system. It could be more loose if you want to use the steam plant. If the system is entirely hydro, located on a single water-shed, that is not a means of relief that is open to you, and it would be less flexible than with steam.

If some unpredictable trouble occurs at one of our hydro plants and results in the outage of that plant, the action of the water-wheel governors in the remaining plants would [fol. 1716] automatically and within a few seconds take up the load power formerly carried by the plant suddenly placed out of operation. This would result in reducing the water release by the amount formerly passing through the water-wheels at the plant which failed, and at the same time increase the releases at all the other plants which pick up the load that was carried by the plant that failed. There has never been a definite order that in such a case our dispatchers should curtail the power supply to our customers by reducing the loads and the water releases at the remaining plants to their former values and immediately restore the water released at the plant which failed to the flow previously existing by operating the sluice gates for spillways. However, we would attempt to make adjustments in releases as rapidly as possible to get back to the schedule, or within the limits which we are given to operate. If, for instance, we were supplying the City of Memphis and the limited instructions given to us for operation were such that we either had to violate those instructions or to leave Memphis in darkness, and if Mr. Woodward or his office would not permit us to change our releases, I am afraid that if we were pressed, some one would have to go without power temporarily, and our contracts provide for breakdowns and similar conditions. Our firm power contracts with cities like Chattanooga, Memphis and Knoxville, do not contemplate the possibility of leaving the cities in darkness or without electric service for a period of time, but if the disaster was great enough our contracts cover those situations. In case of a major failure of high voltage intertie transmission lines connecting one of our plants in our system and carrying a substantial amount of load, the rest of our plants would have to take up the load automatically, [fol. 1717] providing there was no other source or tie be-

tween that generating system that is in trouble and other generating stations.

We supplied a large block of power to the Aluminum Company in December 1937, because they had trouble at Alcoa. That was around 50,000 kilowatts and was at the time when we had our peak. I stated in my affidavit which was made and filed December 11, 1936, in this case, in paragraph 4, that: "The amount of power that is now being sold to customers of the Authority other than the power companies is approximately 22,500 kilowatts." Then I say: "The entire sales of power by the Authority, exclusive of power sold to complaining power companies will not be in excess of 37,000 kilowatts at any time before May 1, 1937." That was an estimate. I think it proved to be fairly accurate. I testified yesterday that I had never requested Mr. Woodward to change any of the instructions which he had issued. By testifying that I had not consulted with Mr. Woodward in regard to any matters except on one or more occasions when some one desired to arrange a test of certain generators, I did not mean to convey that I had never discussed various problems with him. I have never conferred with him about the power requirements. That affidavit of mine also showed an estimate that the kilowatt sales to customers, exclusive of any that might be made to power companies, would be approximately 35,500 kilowatts up to January 1, 1938. In making that estimate, I think we were over the demand.

In a large, reasonably well-loaded utility system obtaining its power from hydro plants, the normal load curve varies from hour to hour. I anticipate that that would be the characteristics of a load curve of a utility in an area such as that where the TVA gives service. The operation [fol. 1718] of a public utility system to meet such a load curve requires hourly adjustments of generating plants; every change in load, so to speak. If your supply is wholly hydro, it requires hourly changes in the water releases at some of the plants. That is, it changes the procedure at the plant. If you are supposed to maintain a constant release below your dams, within certain limits, then you must make adjustments or corrections in gates to make up for the changes in turbine discharges. Whether or not if I did that during the low-water season, I would maintain a con-

stant flow, would depend on my instructions. If I did undertake to maintain a constant flow below all of a system of hydro dams during the low water season, I would anticipate that I would very substantially decrease the firm power capacity of that system. There would be a large part of the time when our typical load curve would require a much smaller amount of water supply than during the peak. If we are fixed with a given flow through the gates, that flow would have to be large enough to meet the daily peak. If you were going to meet that constant flow so as to meet the daily peak, it would mean that you would waste the difference in the water from the standpoint of firm power except for the peak hour of the day. I presume that that would be very substantial on the ordinary load curve if there were no limits. On the basis stated, that would be true.

In the case of the construction requirements of power at Guntersville, we had something on the order of 6500 kilowatts total demand on that project. To the best of my knowledge, the construction requirements at Guntersville, Chickamauga and Norris varied, and I could not state that they would probably run around 4,000 kilowatts each. Some have been slightly over that; some have been under that. I would not say that 4,000 kilowatts was a fair average figure. I am not familiar enough with their equipment. The latest report to Congress—the Hearings for 1939—[fol. 1719] (which appears in the record as Defendants' Exhibit 153)—shows an annual requirement for construction purposes of about 20,000 kilowatts. In my judgment that is a high estimate.

I could not tell what is the firm capacity of Wilson Dam at a 60 per cent load factor. I stated yesterday I had not figured out the firm capacity at Wilson on any basis as yet other than some preliminary figures for 1936. I have not made any calculations for 1937 or 1938. As to how I know that we can supply our firm power requirements if I do not know the firm power capacity of our plants available to us, I will say that if I were merely required to give an estimate, that would be a different problem; but with the flows fixed as they are now for navigation, I am not worrying about our commitments for some time to come. Our commitments are not large enough so that I am not having to worry about the power end of it right at the present time. It is true that at least some part of the power for construc-

tion of Norris Dam was supplied by an interchange arrangement with The Tennessee Electric Power Company. A similar interchange arrangement was made for construction purposes with the Alabama Power Company for Gunter'sville. Wheeler has been served from Wilson, but I could not say for sure that that was true about the very beginning. I understood that the transmission line from Wilson to Wheeler was constructed prior to the commencement of construction of Wheeler Dam. Power was also supplied at Chickamauga Dam by interchange agreement with The Tennessee Electric Power Company up until a short time ago. That was not also true of Pickwick Landing, which has been served from Wilson.

I do not know what is included in "minimum reserve" in the table on page 1000 of this year's Hearings on the TVA [fol. 1720] appropriations (Defendants' Exhibit 153). I have not seen any plan set up as to outages of units for purposes of minimum reserve so far as the TVA is concerned. I do not know what is meant by the note at the bottom of the table showing "40,000 kilowatts under contract as available". I have not been furnished with any rule curves for the operation of these reservoirs.

We do not list the Volunteer Portland Cement Company among the industrials, because we have assigned that to the City of Knoxville. That is a contract for firm power.

The power at Wilson Dam was at all times sufficient to supply all of the demands for power for construction being carried on by the TVA, if we had had interties of lines to the construction projects. We have already stated that we had interchange agreements with the existing utilities to supply power for construction. I do not presume they could install the power generating facilities at the dam under construction until it was completed. That power at Wilson would have been more than enough to supply all lockage requirements. We have three stand-by steam plants under my jurisdiction. Two of them are very small stations and the third one is the Sheffield steam plant, located at Wilson Dam. One of the small stations is at Corinth and one at Tupelo, Mississippi. The large one at Sheffield is on the reservation at Wilson Dam. That plant is in condition to operate.

The TVA does not operate the lines of the cooperatives. I most assuredly think that they now have independent

operating forces. We have no understanding with the co-operatives to help them restore service on lines when they are in trouble due to outages or from other trouble. To the best of my knowledge we do not. I am head of the department that has charge of that. The TVA, under the direct charge of Mr. Sullivan, did go to Tupelo and restore its system and the TVA was paid for that. In the instances that we have assisted a cooperative, we have been paid for that service.

The Lauderdale Cooperative is in the vicinity of Florence and Wilson Dam. That is quite a good sized operation for a rural line with something like 800 customers.

Examination by the Court:

This is not a dollar a year service. We are paid for these services and have been paid for these services from time to time our exact expenses, plus the customary overheads.

Cross-examination continued:

That is not necessarily a recent change in our method of operation, but we have not been called upon here recently to the best of my knowledge. We show the Lauderdale County item on Sheet 4 of Defendants' Exhibit 147 as "temporary rural", with 885 customers. There were a great many of those lines in Lauderdale County that were taken over from the Alabama Power Company. However, the TVA has constructed a considerable number of miles of line in Lauderdale County. The 160 customers shown on the first sheet were previously served directly by the Alabama Power Company. We have enlarged the mileage, and taken on more customers. We have attempted to develop that system. I presume, according to this, that we have been operating that system as a direct retail operation for about four years and we are still operating that as a direct retail operation. The direct retail operation near Muscle Shoals was also included. We have some 2000 or more direct retail customers in the two areas that were mentioned; that is, the Norris Dam area and the Wilson Dam area. That included customers living on the reservation and in the adjacent territory. Referring to the direct retail operation shown on Defendants' Exhibit 136 B, which is the largest operation shown on that map, we are operating in two counties direct. That is the area

shown with the brown or yellow line. In the northwest corner of Alabama are Lauderdale and Colbert counties, shown as temporary rural. We also have Colbert County there which has been in operation directly for four years and is still in direct operation. I have no contract indicating the disposal of those properties and I am not in position to know whether they are negotiating for their disposal or not.

Referring to sheet 15 of Defendants' Exhibit 147, we show there the Rockwood, Alabama Stone Company. I would have to refer to the contract to make sure whether it is to supply a stone cutting company operation at a particular location. I haven't the record here to answer whether we have a second contract with the Rockwood, Alabama Stone Company for serving its quarry at Adair as an entirely different operation. I cannot state as to whether we have one at a different location. I do not have anything to do with the negotiation of those contracts. The reference to the Rockwood, Alabama Stone Company is clear on sheet 2 of Defendants' Exhibit 143.

I could not say for sure that the operation of the Rockwood Alabama Stone Company shown on sheet 2 of Defendants' Exhibit 143 is a stone cutting plant. I don't know. I don't know whether it is a quarry operation or what it is. I know approximately where it is located. It is close to Russellville, Alabama.

[fol. 1723] I was asked a series of questions on direct examination relative to whether or not the power contract of the Monsanto Chemical Company with the TVA was with the Monsanto Chemical Company of Delaware and I said that it was. I investigated that merely by the contract which I have in my possession. I couldn't say whether it is a fact that on May 15, 1936, the date of this power contract, the Monsanto Chemical Company of Delaware was qualified to and was doing business in Alabama. I don't know that, nor do I know whether on the same date the Monsanto Chemical Company of Alabama was qualified for and doing business in Tennessee. As to whether it is a fact that the Monsanto Chemical Company of Alabama is a wholly owned subsidiary of the Monsanto Chemical Company of Delaware, I have not investigated that. I have not looked into it sufficiently to say whether these corporate

entities are run by the same officers and the same management. I don't know that whether prior to and on May 15, 1936, the date of this contract, all elemental phosphorous produced by the Monsanto Chemical Company of Delaware or Alabama was produced by the electric furnaces at Anniston, with power purchased from the Alabama Power Company. I don't know that coincident with the building of the phosphorous production by electric furnace operation with TVA at Columbia, Tennessee, by Monsanto Chemical Company, the phosphorous production at Anniston was curtailed. I am not aware that when the Columbia furnaces were brought up to capacity the production at Anniston was entirely displaced. I don't know anything about that. I think there have been estimates of the kilowatt sales to [fol. 1724] Monsanto at Columbia, but I could not say for sure what they are. I would anticipate them to be very large. When I gave some figures of about 800 kilowatts to Monsanto, that was during the construction period. We had committed ourselves to serve Monsanto in large blocks when construction was completed. That was true under the contract then in existence.

(The documents consisting of nine water control bulletins, the last being dated June 28, 1933, which had been produced by the defendants, were offered and received in evidence as Complainants' Exhibit 923, and the documents consisting of water control memoranda Nos. 1 to 24 inclusive, the first being dated July 27, 1937 and the last being dated December 31, 1937, which had been produced by the defendants, were offered and received in evidence as Complainants' Exhibit 924.)

I don't know whether the customers served directly by TVA are served on established rate schedules. I have nothing to do with the rate schedules, we are dealing with the customers as a whole. I have nothing to do with the schedules under which they are served, or how they are served, except for operations.

No departments are set up definitely in my division of power operations other than system operation plants, that is, generating plants and transmission and distribution. My department is included in the larger department of operations. Mr. A. H. Sullivan is head of the department of operations and under him comes the administrative office. Then there is a division of engineering and construction

headed by Mr. W. W. Woodruff; the division operations headed by various division managers; and the division for promotion, headed by Mr. H. A. Warner. A certain amount of the promotional work comes under Mr. Warner. I do not know definitely under whom the other promotional work comes.

[fol. 1725] Redirect examination:

"Q. Mr. Karr, I have just a few questions which were brought out by the cross examination. In reply to one of Mr. Jackson's questions, Mr. Karr, I understood you to say that to meet a system load curve, to meet the requirements of the system load curve, water must be released as necessary to meet the requirements of the load curve from time to time. Now, I wish to ask you whether in saying that it must be released you meant that in your case it must be released regardless of the instructions given you by the water control division?

Mr. R. T. Jackson: I object to that question, I don't think it is proper. All I asked him was whether to meet the load curves they had to have releases of water.

Judge Allen: Objection overruled, he may answer.

Mr. R. T. Jackson: Exception.

A. I think I qualified that statement when I made it. The water to meet load requirements must be released, but we have certain limits to operate under. Under our instructions, we do have a slight leeway, primarily in connection with maintaining certain river stages for navigation and flood control."

On cross examination, I was asked whether, if there was a breakdown of one particular unit that went out of operation and the load would have to be taken up by the other generating units either there or elsewhere in the system, it would not be necessary to adjust the releases for the other remaining units so they could pick up the load, and I said it would be. By releases I meant releases for our turbines. We would only be permitted to adjust the releases as a whole as far as our instructions were concerned from the water control division. The water control planning division fixes the limits of our discharges from a particular dam. When I speak of adjustments of releases made

by my particular division for power requirements, those adjustments have always been made within the limits of the [fol. 1726] discharges fixed by the water control division. I was also asked whether in the event Mr. Woodward should issue an order to shut off all flow I would be able to carry out the contracts which require notice before cutting off the power. Upon getting orders from Mr. Woodward, if it was to the extent that it did conflict with our commitments under power contracts, I would first call the matter to Mr. Woodward's attention and see if he could not make such adjustments as would accommodate them, and then if he could not, there would be nothing else for me to do but curtail power.

I also testified on this same subject of what would happen in a breakdown situation. Certain of the contracts contain clauses which have special provisions relating to contingencies arising from floods, which would excuse an interruption of service.

Examination by the Court:

As to whether in the event of failure to produce the required amount to supply our contractors from the hydro plants we have any auxiliary plants of any kind to fall back on, I don't know whether there are any other plants, such as steam plants, contemplated or not. There are none in operation to the best of my knowledge. I might explain in that connection that we do have emergency agreements with some of our customers that they will supply us up to their full facilities in case we have a serious breakdown in our system. That is direct customers who have plants of their own and buy our power in addition to what they produce themselves.

[fol. 1727] In addition to the water control bulletins which have been put in evidence, we also receive oral advice and instructions from the water control division frequently during flood seasons, that is, when the rivers are in flood stage. For example, during the great flood beginning in December, 1936, and running over through January, 1937, all instructions at that time were oral. There were certain days when we were getting them almost hourly, and we never missed daily communication. There is a gap in the specific written instructions during that particular period, during which all the operations were carried on through oral instructions.

With reference to the difference between the estimates which I made in my written affidavit offered earlier in the trial, of power sales to customers who were then under contract and my recent peak sales, the estimate in my affidavit was estimated on the basis of existing contracts.

Defendants' Exhibit 142 shows that there were substantial releases of water over and above that required for generation.

I stated on cross-examination that certain industrial contracts were for a term of 20 years. The special contracts with the Aluminum Company and the Arkansas Power & Light Company are for less than 20 years.

Referring to the 160 customers in Lauderdale County, shown on sheet 2 of Defendants' Exhibit 147, I testified that they were Alabama Power Company customers transferred to the TVA and made a misstatement there. The Alabama Power Company properties were transferred to the TVA in 1936 and this was 1934 that we were referring to. Those particular customers were not customers transferred at that time by the Alabama Power Company. They were not [fol. 1728] treated as customers of the Alabama Power Company. Those customers in Lauderdale County are part of the 2000 customers who were located in the immediate vicinity of Wilson Dam, on government reservations and on rural lines running out of those reservations. They are part of the customers that were mentioned.

Recross-examination:

I said that the TVA had some interchange agreement, or something with customers or companies. Those are embodied in the contracts which are in evidence in this case. Any interchange agreements we have will be found in those contracts. Even as to firm power, in cases of certain emergencies and floods, we would be permitted to interrupt power under some of the contracts and not be held liable if there was an interruption of service in a case such as an act of God.

Redirect examination:

I was asked about certain work done at Tupelo by the TVA. As to the circumstances which brought TVA into that situation, to my knowledge there was a severe cyclone which

struck Tupelo in the early part of April, 1936. I say it was a severe cyclone, because I have been in the country where they have cyclones, and I never saw as much damage done in any one place as was done at Tupelo, and we assisted them at that time on their call. They called us in to help them out in repairing the lines.

(The witness was excused.)

“Mr. Fitts: At this time I would like to offer in evidence as defendants’ exhibit No. 150 the stipulation of the parties with respect to purchases of power by the complainant companies under the contract of January 4, 1934. I would like to say in that connection that Mr. Jackson asked me the question yesterday as to whether the examination of Mr. Karr was intended in any way to vary from or contradict the stipulation, and it simply seemed to me that in order to make it perfectly clear and to complete the record on the subject, since there is testimony in the record on it, we ought to put in the agreement of the parties on the subject, and I offer it for that purpose.

Mr. R. T. Jackson: We object to that as incompetent, irrelevant and immaterial. It is on the question of estoppel that was up yesterday and we agreed or stipulated as to the facts, as to what power was taken, and all that sort of thing. It is the same sort of thing that was sought to be proved yesterday.

Judge Allen: If this bears only on the question of estoppel the objection will be sustained.

Mr. Fitts: I am not willing to concede that. There is quite another question and that is this, it has been strenuously contended throughout this case that there is no place for power that is going to be generated at these Government dams to go; there is no need for it, in other words. That it is going to be thrown onto an already glutted market. Now, it seems to me that the fact that these private utilities have found it desirable and in fact necessary, we might assume, to purchase this power in low water seasons particularly, when they haven’t got enough at their own plants, is very material on that proposition.

Mr. R. T. Jackson: We continue our objection and do not agree with counsel’s statement with reference to the purchase. It is not a question of necessity, it is a question of—

Mr. Fitts: The fact that purchases were made, it seems to me to be at least relevant on the question of whether there is an over supply on these systems.

Mr. R. T. Jackson: I don't think that is so. You have heard of nuisance values, Mr. Fitts.

Mr. Fitts: It seems to me it is always a pretty good inference when a man says, 'I have got too much of something' and then goes out and buys it from somebody else, it is a pretty good inference that he hasn't got too much of it.

Judge Allen: Just a moment, please. May we confer?

[fol. 1730] Judge Gore: If we understand you, Mr. Fitts, you claim that this has a bearing upon the question of adequacy of these facilities of the complainant companies?

Mr. Fitts: I would not put it that way, your Honor. I think there are two separate questions. I think there has been some confusion about our purpose in producing any evidence on that subject. We are not interested in this case, legally, as I see it, in whether or not the complainant companies have done a good job or whether they have had prudent management. But there may be an interest in whether or not there is any need for this additional power that is being generated here; whether there is any place for it to go. And I think that the showing that there have been large purchases of power by these companies, over this period of time, is relevant on that question as to whether or not there is any place for this power to go, and whether there is any need for it; in other words, whether their systems are overloaded with surplus generating capacity to such an extent that if you throw this power on the market there is no place for it to go.

Judge Martin: After all, Brother Fitts, isn't that the question of adequacy, which was the question asked by Judge Gore?

Mr. Fitts: I think it is a different angle of the question, because I don't want to be understood here as making any point on whether or not the complainant companies as they now stand, are rendering adequate service. I don't think that is material. The question is whether or not in the reasonable future there is to be a need for additional generating capacity in this area, if that itself is relevant. The complainants have raised it. I doubt it myself.

Mr. R. T. Jackson: If the Court please, I want to say this, the facts about this, if it is material, to be received in evi-

dence, along the line offered by Mr. Fitts, or suggested by Mr. Fitts, requires us to offer proof to show, I think the following things: First, this power which was purchased was used only as steam replacement at the request of the Government. And we had at all times generating capacity more than enough to supply our needs. We bought it in part, frankly, as the Court would realize, for its nuisance value, because——

Mr. Fitts: I object to this statement unless it is an offer to prove. I don't know what it is. Are you testifying or what?

[fol. 1731] Mr. R. T. Jackson: I am stating what I think we would have to go into.

Judge Gore: He is answering your statement, I think.

Mr. Fitts: He is stating what the facts are, he is not stating what a legal theory is. He is stating facts. I was stating what I considered the relevancy of this testimony. He is stating facts that ought to be presented in this record by witnesses.

Judge Gore: Unless he is sworn and takes the witness stand, I don't think we are going to consider him as a witness.

Judge Allen: Finish your statement, Mr. Jackson.

Mr. R. T. Jackson: We were confronted with a situation and not a theory, and we purchased for nuisance value. We can prove, if it is material, not only that we had adequate facilities to produce all of the power that we were purchasing from the Government, and that was long before TVA, as the Court knows, but we can produce evidence to show that we could produce it cheaper than this incremental power. I think that it is irrelevant, incompetent and immaterial, and if it goes into evidence, I think we are confronted with the necessity of explaining those facts.

Mr. Fitts: To borrow Mr. Jackson's expression, I am not intimidated by the threat of additional evidence. The Court will rule on that when it is presented.

They have agreed that the facts stated are correct.

Judge Martin: We would not be drawn into immaterial issues.

Judge Allen: This is your stipulation, Mr. Jackson.

Mr. R. T. Jackson: What is it, if the Court please?

Judge Allen: This is your stipulation?

Mr. R. T. Jackson: Yes. We do not in any way contest the facts, of course, that are set out in that stipulation.

Judge Allen: Yes. You stipulate that these tables correctly set forth the facts. The Court receives this exhibit in evidence. It will not consider it in connection with any question of estoppel, which the Court has ruled out of this case. It will consider it in connection with the matters stated by Mr. Fitts.

Mr. R. T. Jackson: May we have our exception?

Judge Allen: Yes, you may have."

[fol. 1732] JAMES S. BOWMAN was recalled as a witness on behalf of the defendants and, having been previously sworn, was examined and testified further as follows:

Direct examination:

There are a few questions and answers in my previous testimony which I think ought to be clarified or amplified in order to avoid misleading the Court as to what I meant to say there. From the individual questions asked me I was thinking that counsel for complainants wanted actual rules for the operation of the reservoirs. Then when I got the transcript and read over the questions in toto it appeared that counsel for complainants might also have had in mind any studies which we have made on that. My answer was correct in that the power section had set up no actual rules of operation for the reservoirs, but they had made a great number of studies of the sort mentioned, of which I was aware, and some of which I had supervised at one time. That is as to malaria control. I am making a distinction between studies and actually setting up rules to govern the operation. There is an error in the tabular statement, Defendants' Exhibit 45, which was produced by me during my prior examination, relating to Guntersville project. There is a slight error given in the capacity of the units in lines 14 and 15. I gave it as 25,000 kilowatts. As a matter of fact, the way the specifications finally went out, which I had not checked up on, it was 24,000 kilowatts.

The table (offered and received in evidence as Defendants' Exhibit 45-A) has been prepared to correct that error.

There is also an error in lines 14 and 15 of Defendants' Exhibit 46, which is a tabular statement relating to the Chickamauga project which was produced by me during my

prior examination. The capacity of the generators should [fol. 1733] be 27,000 kilowatts instead of 25,000 kilowatts. I might say that this discrepancy came about because there was a considerable difference of opinion as to whether the turbines on those projects should be made the same physical size, or the generators should be made the same physical size. In my set-up I had the generators the same physical size, and it was later determined, for various reasons, to make the turbines the same physical size, which made a slight spread in the size of the generators, reduced the size of one and increased the size of the other. The table (offered and received in evidence as Defendants' Exhibit 46-A) has been prepared to correct that error.

We have studied all of the sites of the main stream of the Tennessee River for dams and reservoirs that will provide a 9-foot channel and control floods on the Tennessee River and reduce the contribution of the Tennessee to the Mississippi River. We are still studying three sites, Gilbertsville, Watts Bar and Coulter Shoals. These are for the purpose primarily of obtaining a 9-foot navigable channel with minimum over-depth of two feet and for obtaining as much flood control as we feasibly could. The Norris site had already been fixed at the time I came with the TVA and started my investigations. I made studies of the Hiwassee site. We have made some reconnaissance investigations of other possible sites on the tributaries, but so far we have made no detailed investigation of those sites.

"Q. From the studies you have made are you able to say whether or not there are also valuable waterpower resources available at these navigation and flood control sites which you have named?

Mr. R. T. Jackson: I object to his giving any testimony about navigation sites, because he is not qualified.

Mr. Fitts: If that objection is seriously made, I will ask Mr. Bowman to state to the Court the nature of his work in detail, since he has been with the TVA during the past three and a half or four years, as to how it relates to navigation problems and navigation conditions on the Tennessee River."

[fol. 1734] Very shortly after I came with the TVA, I started to make studies, and I believe the first man who came with me was Mr. C. T. Barker, in charge of the navigation

section of my division. He has worked continuously in that work ever since, and we are studying very intensively the prospect for navigation on the Tennessee River and the proper sequence for obtaining that navigation. We worked very closely with the Army Engineers through those years on locks, marking of navigation, dredging, and various navigation operations. I was actually the man in charge of the part of the work to determine the design and lay-out of the main stream projects, as well as the tributary projects, after I arrived. Mr. Barker was working under my supervision and direction specifically on navigation problems. Since last June, I have had charge of the project planning solely. Before that I had charge of all system investigations, but I no longer have that, so Mr. Barker is not under my supervision in navigation planning. However, I now have the navigation operation section which is charged with seeing that all of the navigation facilities are actually carried out during construction, charged with terminal design, design of floating equipment, and various other actual operations concerning navigation. During the period which I described, when the investigations and studies were under way, Mr. Barker reported directly to me.

"Mr. Fitts: I think that is sufficient, if the Court please.

Mr. R. T. Jackson: I renew my objection. The secretary of War has charge of all members of the Corps of Engineers, so far as I know, but that would not qualify him as an expert.

Mr. Fitts: You don't deny that he is qualified as a hydraulic engineer, do you?

Mr. R. T. Jackson: No, but I do as to design and operation.

Judge Allen: The objection is overruled.

[fol. 1735] Mr. R. T. Jackson: May we have an exception?

A. Yes, I think that at all of the sites we have constructed, which are under construction or in process of investigation, there are valuable power resources at those sites."

There are not a great number of available flood control reservoir sites in the Tennessee Valley. That is principally because a good flood control reservoir site is rather a coincidence. A good dam site with a large reservoir above it, properly related to the rivers and the drainage basin to be controlled, and with reference to the point at which floods are to be controlled, is rather rare; you don't find many of

those. It is my opinion that if dams were built at the available sites on the tributaries of the Tennessee River purely for local flood control, they would practically forestall the building of dams later for the improvement of navigation, control of floods on the Tennessee, Ohio and Mississippi Rivers, and provisions for low water releases. It seems probable to me that most of these projects designed for a single purpose would not be well adapted for multiple use, or would be relatively too expensive if it were proposed to convert them to multiple purposes, so, therefore they would stand for a single purpose, and would probably forestall multiple-purpose dams to be built on the same sites later. Whether or not the construction of dams on the tributaries designed solely for local flood protection without any provision for generation of power would have a similar effect upon the subsequent development of the potential power resources which I mentioned as being available at those sites would depend on how they were designed. But if they were designed with tunnels or conduits at the bottom, and had various sorts of control works, pen-stocks might be connected in the future—and again they might not be. It is very difficult to tell without a specific design.

[fol. 1736] Assuming that the Federal Government constructed a series of 32 low, movable, wicket navigation dams upon the main stream of the Tennessee River, and assuming that it was later determined to construct high dams on the main stream of the Tennessee River capable of producing electric energy and with flood control provisions, except on the assumption that low dams may have reached the end of their useful life at that time, probably the later improvement would be forestalled, or else a considerable residual part of the investment in the low dams would be sacrificed when they were drowned out or flooded out by the high type of dams which you require for the purpose suggested. In other words, if you built such high dams with a low dam system in, you would flood out the low dams and have to remove them and duplicate your investment, unless they had reached the end of their usefulness.

Examination by the Court:

It is my opinion that it probably would not be feasible to make a system of low dams into high dams of the type that is being constructed by the TVA, or any kind of a high

dam capable of producing hydro-electric energy and with flood control features. I would not attempt to do so.

Direct examination continued:

There is a great difference in foundations. For one thing, the low dams could be founded on a soft base—that is, on sand and gravel, with piling—while the high dams obviously require a rock foundation of the type we are constructing now. Furthermore, it would only be, say, one out of three or four of the low dams which might occupy the same site as the high dam; and the others would be drowned out and could not be incorporated, because they would be upstream in the pools.

[fol. 1737] All of the dams which have been constructed or are under construction or investigation by the TVA provide at minimum draw-down elevation a navigable depth of 9 feet back to the next dam upstream. The navigable depth of 9 feet refers to a 9-foot draft with a minimum of 2 feet over-draft or over-depth. This depth occurs at what we call the minimum flat pool elevation, and the water at the dam downstream may be drawn lower than this, depending on the flow of the river, and still maintain this depth at the upper end of the pool. Above these levels up to the maximum surcharge level, which is the top of the gates, is storage which is useful for flood control storage. The design of the main river dams makes provision for storage capacity above minimum draw-down elevation, above the flat pool level or above the minimum draw-down elevation, which depends on the flow of the river. All of the storage above that and up to the maximum surcharge level would be operated, or can be operated for the benefit of flood control.

“Q. Mr. Bowman, will you state whether or not the sites, order of development, and features of design required in a dam designed for navigation and flood control differ in any material respects from that which would be dictated if the projects were to be constructed and operated primarily for the production of power.

Mr. R. T. Jackson: We object to the qualifications of the witness as to the navigation feature.

Judge Allen: The objection is overruled.

Mr. R. T. Jackson: May we have our exception, please?

A. As to most of these dams, there are such features which differ in material respects from what would be used

if the dam was designed primarily for the production of power.

Q. Now, will you state whether or not every provision has been made in the design of the projects under construction by the Tennessee Valley Authority which is necessary or useful in the operation of those projects for navigation and flood control?

Mr. R. T. Jackson: The same objection as to the competency of the witness on navigation.

Judge Allen: The objection is overruled.

[fol. 1738] Mr. R. T. Jackson: May we have our exception, please?

(The Witness: Yes, to the best of my knowledge, these provisions have been made so that they meet all of the requirements of that operation, with certain provisions which give a great deal of flexibility in the operation, considering the system should be operated as a whole, that is, I think that we have gone further, perhaps, than we would with an isolated dam simply to meet system requirements in respect to the navigation and flood control.

Q. Now, Mr. Bowman, are there any features in the design of these tributary reservoir projects constructed or under construction by the Tennessee Valley Authority that are valuable in flood control and navigation, which differ in any way from those that would have been provided if those dams were constructed and operated primarily for the production of power?

Mr. R. T. Jackson: The same objection as to the competency of the witness, so far as the navigation feature is concerned.

Judge Allen: The objection is overruled and the Court will restate its opinion on this matter. We consider that substantial experience with the Authority in these matters is experience.

Mr. R. T. Jackson: May we have our exception noted?

Judge Allen: And that experience of the amount and nature that this man has had qualifies him to testify as a witness on these matters. Your objection, in other words, goes to the weight.

Mr. R. T. Jackson: I understand the view of the Court. I am renewing it to preserve my record as the Court will understand.

Judge Allen: You may have your exception.

Mr. R. T. Jackson: Exception.

A. There are such provisions. Principally, they are sluiceways of unusually large capacity at a fairly low elevation in the dam."

At elevation 1020 the capacity of the sluiceways at Norris is approximately 36,000 second feet. At Hiwassee with the pool at elevation 1526 the capacity is approximately 22,000 second feet.

[fol. 1739] Examination by the Court:

In a dam such as Norris Dam, the intakes to the turbines and to the sluiceways are entirely separate. That is, they are separated by some distance. The entrance to the sluiceways at Norris is down toward the bottom of the dam. The elevation of the center of the sluiceways, referring to Defendants' Exhibit 49, is 865, and those sluice-ways are ten feet high, so that it extends from 870 to 860. There are eight sluice-ways at Norris. The sluice-ways simply conduct water from the Norris pool to the down-stream side of the dam. They discharge directly without going through the turbines. There is no connection between the turbines and the sluiceways, physically, whatever.

Cross-examination:

The center line of the pen-stocks is 867 at the intakes, and those pen-stocks are 20 feet in diameter. That would be approximately from 857 to 877. There is a little bell mouth at the entrance, so that is not strictly correct, but it is just about that.

Direct examination continued:

The total combined discharge capacity of the two turbines at Norris is approximately 8,000 second feet. I believe it is slightly above that at the higher elevations and slightly less at the minimum. At Hiwassee the water capacity of the two turbines, whenever they are ultimately installed, will be approximately the same as at Norris. Those are not exact figures. I do not know the results of the recent tests at Norris, but they are approximately correct. At Norris the capacities of the sluiceways is over four times

the capacity of the turbines, and at Hiwassee it is over two and one-half times the capacity of the turbines. Sluiceways with those discharge capacities enable you to hold the reservoir [fol. 1740] at low elevation during the flood season, or to pull them with a considerable degree of rapidity down to the proper elevation for the storage of a flood. If you have small sluice-ways, approximately the capacity of the turbines, say, you could not accomplish these operations for flood control with that facility. As a matter of fact, you might have a discharge into your reservoir equal to the capacity of the sluiceways if they were upon the order of 8,000 or 10,000 second feet, and you would not be able to lower the reservoir for a long period of time. With 36,000 second feet, it is so much in excess of the capacity of the stream flow, except during the peak of the flood itself, that the discharge would rapidly become greater than the inflow and consequently draw the reservoir down.

There are certain features of design in the projects on the main stream of the Tennessee River which differ from those which we have been providing, and which would be provided if the projects were to be operated primarily for power. Particularly at Pickwick and in the present plans for Gilbertsville, we have spillway capacity in excess of what would be required to pass the maximum probable flood. This is for the purpose of holding down the elevation of those two pools in advance of a flood until the discharge becomes very high and you are almost ready to store water in the surcharge space. The Wilson Dam is considerably higher than any of the main stream projects being constructed by the TVA. The head at Wilson normally is about 92 feet, while at any of the projects we have, I think perhaps Coulter Shoals might be as high as 70 feet, that would be the highest, most of them average about 50 feet. I am speaking now of the difference in elevation between normal water below the dam and normal water above the dam.

[fol. 1741] From the standpoint of facilities provided for navigation and flood control, there are material differences in the structure and design of Wilson Dam and the dams constructed or under construction by the TVA on the main stream of the Tennessee River. For one thing, the pool at Wilson is only 15½ miles long, which means that you reach another lockage in that distance above Wilson, while the

shortest of the other pools which the TVA is constructing, I think, is 50 miles, and the average is about 85 miles, which means that you have a longer pool without lockage on the other projects. As to flood control, at Wilson you would probably get around 40,000 acre-feet in a pinch, but even to get this the maximum pool level of Wilson Dam should be raised between one and two feet, which would enable you to get probably somewhere between 40,000 and 45,000 acre feet of flood control storage. Of course on the other projects the flood control storage is very much greater than that.

“Q. Now, Mr. Bowman, generally in your opinion, when the dams on the main stream, constructed and under construction by the TVA are completed, how will that compare with Wilson Dam with respect to their value and usefulness for navigation and flood control?”

Mr. R. T. Jackson: I object to that on the ground that the witness is not qualified on navigation.

Judge Allen: Objection overruled.

Mr. R. T. Jackson: Please note my exception.

A. In my opinion, the other dams will be more valuable than Wilson for both purposes, considerably more valuable.”

The principal difference in design between the projects constructed or under construction by the TVA on the main stream and Hales Bar Dam is that the TVA projects have high crest gates which can be readily regulated at any time as to the amount of water discharged, and the storage in the reservoir above and below what we term normal pool level, or between the minimum navigation level and the surcharge [fol. 1742] are readily controlled. At Hales Bar there are flash boards, approximately 3 feet high, which do give a measure of control above the fixed spillway crest, but that volume is rather small and it is difficult to control those flash boards deliberately during the progress of a flood. Under certain conditions you can drop the flash boards, but until the flood is entirely over, it is impossible to set up the flash boards again.

There is a relationship between the spillway capacity which I have testified as being provided at the projects constructed and under construction by the TVA on the

main stream and flood control. At Pickwick and Gilbertsville the spillway capacity is greater than that required to pass the maximum estimated flood in order that the level of the pool can be held at a low level during high discharges. Of course, there is also a provision for surcharge which is incorporated in the spillway gates; that is, the top of the spillway gates is fixed higher than it ordinarily would be except for flood control.

"Q. What are the determining factors in determining the proper location of navigation facilities such as locks on projects such as Pickwick or Wheeler on the main stream of the Tennessee River?

Mr. R. T. Jackson: I make the same objection to the competency of the witness.

Judge Allen: Objection overruled.

Mr. R. T. Jackson: Exception.

A. The controlling engineering factor is to locate the locks at such points that the approach both up and downstream will be most advantageous for navigation."

Those conditions usually favor one side of the river. In all of the main stream projects constructed or under construction by the TVA, the power house has been placed at the opposite end of the dam from the navigation locks in order that the releases from the power house during the stages of the river and flows in the river that ordinarily [fol. 1743] obtain, will not interfere with the entrance into a lock downstream. If the power house was right alongside the lock there would be eddies around the downstream walls which would interfere with them to a considerable extent.

"Q. Will you state whether in your opinion this relative location of the locks and the power houses has been favorable or unfavorable to navigation?

Mr. R. T. Jackson: I make the same objection to the competency of the witness.

Judge Allen: Objection overruled.

Mr. R. T. Jackson: Exception.

A. It has been favorable to navigation. As we carried out the purpose which I first stated, we were very careful to locate the locks in such position that the approach up and

down stream would be the most favorable that could be obtained. This was checked over with the district engineer in Nashville, we exchanged opinions in that respect, we inspected the site on the ground, and finally came to an agreement as to what the best location was and that was where the lock was built."

At all of the projects on the main stream constructed or under construction by the TVA, space has been provided for the installation of an additional lock in the future whenever the capacity of the present lock may be reached. At Pickwick the size of the present lock is 600 feet by 100 feet wide. The provision there is for an auxiliary lock of small size, 60 by 360 feet. Above Wilson Dam, space has been left alongside of the smaller locks, which are 60 by 360, for later construction of a large lock 600 by 110 feet in dimension. Considerable expense has been involved in making these provisions, both in the way of excavation and carrying the sheet piling and masonry into the embankment, so that the larger locks may be readily built at a later date.

The table (offered and received in evidence as Defendants' Exhibit 151) is entitled "Storages in TVA main [fol. 1744] stream projects in acre feet". It was prepared from previous exhibits which have been submitted by the defendants. It summarizes the figures that appear at the bottom of Defendants' Exhibits 39, 42, 43, 46, 47 and 48.

The document (offered and received in evidence as Defendants' Exhibit 152) is a photostat of part of pages 71, 72 and 73 from House Document 328. Referring to the table in Defendants' Exhibit 152 appearing on page 73, as to day second feet, one day second foot would be one cubic foot of water flowing every second for 24 hours. Since there are 86,400 seconds in a day, there would be that many cubic feet of water in one day second foot. One acre, one foot deep, which we call an acre-foot, contains 43,560 cubic feet. So, dividing the former by the latter, it gives a conversion factor of 1.984. We multiply day second feet by that figure to get acre-feet. Customarily that is called simply a conversion factor of two, because it is so close to two, and that is what we actually use; but more precisely it is 1.984.

In the TVA table (Defendants' Exhibit 151) I think the volume figures refer to elevations which are slightly below flat pool level, that is, what we gave as minimum navigation level, while the table from House Document 328 (Defend-

ants' Exhibit 152) shows what that document calls normal pool level, which is minimum flat pool level. There is a very slight difference between the two. The ratio between flood storage and total volume of the pool is very much greater in the TVA projects as shown on Defendants' Exhibit 151, which represents the projects constructed, under construction or under investigation by the TVA, than in the projects from this table in House Document 328 shown in Defendants' Exhibit 152.

[fol. 1745] "Q. Mr. Bowman, in your opinion, what order of development of projects on the Tennessee River and its tributaries was most desirable at the time of the passage of the Tennessee Valley Authority Act in order to improve navigation on the main stream of the Tennessee and to reduce floods on the Tennessee and Mississippi Rivers?

Mr. R. T. Jackson: The same objection as to the competency of the witness on the navigation features.

Judge Allen: Overruled.

Mr. R. T. Jackson: May an exception be noted, please?

A. It is my opinion that the program which has been followed by the TVA was the proper one for the accomplishment of those purposes. Starting with Wilson Dam, the next one for the improvement of navigation in the lower section of the Tennessee River was Wheeler Dam, which had been started by the Corps of Engineers for that purpose. The particular obstruction in that stretch of the river was the cross-over between the head of the old Muscle Shoals Canal and the foot of the Elk River Shoals Canal, the minimum depth of about $1\frac{1}{2}$ feet on the crossing, which was virtually the head of navigation except for very small craft or in medium high stages of the river. The Wheeler Dam drowned out this obstruction and extended a nine-foot draft practically to the town of Guntersville and somewhat beyond the site at which the Guntersville Dam is being built at the present time. After Wheeler, the worst stretch in the lower section of the river in which there was a substantial bottle neck was in the vicinity of Sheffield and Tusculumbia, where a minimum depth in the Sheffield cut, Buck Island cut was between 4 and $4\frac{1}{2}$ feet at low water. In the Colbert Shoals Canal further downstream, the canal is sinuous, rather narrow, not adapted to barge traffic.

The construction of Pickwick Dam eliminates both of

these obstructions and will give a nine-foot draft up to the entrance of Lock No. 1 at Florence. Below Pickwick, there was a minimum depth in Big Bend Shoals of about $4\frac{1}{2}$ feet, and after Norris which had already been authorized by Congress was completed, this would be increased to about $6\frac{1}{2}$ feet minimum, which gave a better depth than at many sections further up the river. Although that was still somewhat short of the nine-foot depth, at the same time a $6\frac{1}{2}$ foot depth will allow a considerable degree of traffic. And there were other sections of the river which had much shallower depths, and which it seemed should be improved first. Furthermore, for several years we had not located the proper site for Gilbertsville Dam, which has only been accomplished within the last year. We were not in position to improve the lower stretch between Pickwick and the mouth until we had definitely located that. As a matter of fact, those explorations took something like three years before we finally settled on the Gilbertsville site.

[fol. 1746] Q. Where was the most logical project in your opinion for the improvement of the navigable channel of the main stream of the Tennessee River after the construction of Pickwick?

Mr. R. T. Jackson: May I have the same objection with reference to the competency of the witness?

Judge Allen: You may have the same objection. Is this not something that has already been gone over once?

Mr. Fitts: Your Honor, as I recall, the only way it is in is that on redirect examination I read to Mr. Bowman a part of his testimony in the Ashwander case relating to a part which Mr. Jackson had read on cross-examination, which did cover this. No witness has actually testified from the stand in this case to these facts.

Judge Allen: The objection is overruled.

Mr. R. T. Jackson: May we have our exception?

Judge Allen: He may answer.

A. Considering the fact that the Chattanooga area would probably be most productive of navigation traffic, there were still sections of the channel above the head of the Wheeler pool in which the depth was not over 3 feet in low water, perhaps slightly less, as against a $6\frac{1}{2}$ foot depth below Pickwick, with Norris Dam releases in effect. Therefore, to bring Chattanooga within reach of commercial traffic, it

seemed advisable to build the next site for navigation at the Guntersville site, which would give a navigable depth back to the entrance of the Hales Bar lake; Hales Bar Dam then continues a nine foot depth into the Chattanooga harbor. Now, any additional releases from these main river pools, as they would be constructed, added to the releases from Norris, would give us approximately a 7 foot depth downstream from Pickwick. In other words, navigation with perhaps a six foot draft could then reach clear into Chattanooga, where if that system had not been followed there would have been still sections of the river in which not over a 3 foot draft would have obtained, and have made it impossible to reach Chattanooga with that type of navigation.

Q. Well, in your opinion, would it have been desirable instead of adopting that method to have started up at the head of the river and built the dams down stream, that is, built the dam between Knoxville and Chattanooga first?

Mr. R. T. Jackson: I just wanted to preserve the record. The same objection to the competency of the witness as to navigation.

[fol. 1747] Judge Allen: Overruled.

Mr. R. T. Jackson: Exception noted.

A. To my mind the logical method of procedure would be improvement of the real bottle necks in the lower section of the river up to Chattanooga, and take the worst stretches first."

After the construction of Norris Dam, there were particular projects that were particularly desirable for flood control on the tributaries. Hiwassee was one. Hiwassee gives us a considerable degree of flood control on the Hiwassee River, and furthermore it is on the opposite side of the basin from Norris Dam, which allows us to take some advantage of diversity in storm precipitation. After Hiwassee, Chickamauga Dam immediately above Chattanooga, would be of great benefit in the minor floods anyway, and in the floods which are somewhat larger. Until we get more complete control on the tributaries and Hiwassee is completed, Chickamauga Dam will become increasingly valuable for flood control. Gilbertsville there again enters into the picture. For flood control on the Mississippi, of course, Gilbertsville would have been pref-

erable to some of these other dams which I have mentioned. However, until this last year we have not been in position to fix the Gilbertsville site, and appropriations have not been available, of course, for its construction.

"Q. Mr. Bowman, will you state whether there is any storage space in the reservoirs on the main stream projects either below or above minimum draw down levels that is not useful for either navigation or flood control purposes, or both?

Mr. R. T. Jackson: The same objection as to the qualifications on navigation.

Judge Allen: Overruled.

Mr. R. T. Jackson: Exception noted, please.

A. Below the minimum draw down level of course it requires storage behind the dam to fill up the pool to [fol. 1748] that navigation level. Therefore, all of that storage behind the dam up to the minimum navigation level or to the flat pool level is valuable for navigation. Between the minimum navigation level and the maximum surcharge level, that space is valuable for both navigation and flood control.

Q. In your opinion, in order to provide a minimum nine foot channel on the main stream of the Tennessee River, control destructive floods in the Tennessee Valley and reduce the contribution of the Tennessee River to Mississippi floods, what type of projects on the Tennessee and its tributaries are necessary?

Mr. R. T. Jackson: The same objection as to qualifications with reference to navigation.

Judge Allen: The same ruling. He may answer.

Mr. R. T. Jackson: Exception, and a further objection that I thought he had already answered the same question.

Mr. Fitts: He has not. It was read out of the Ashwander case, but it was never asked to him direct on the stand in this case.

A. It is my opinion that the same type of projects being built by the Authority on the main stream would be necessary for these purposes."

Cross-examination:

As to whether, before my connection with the TVA, I was engineer in responsible charge of designing any large

reservoir, at the Miami Conservancy District, I was not in responsible charge; I was the assistant engineer there. I had been out of college about a year and a half when I entered the employ of the Miami Conservancy District. That was a detention reservoir system. I had responsible charge of the design and construction of a large impounding reservoir before I came to the employ of the TVA. I did some work in the later phases of Dix Dam, increasing the capacity, that is, I was engaged with one or two other men in responsible charge of that work. The engineers in responsible charge of that construction were Harza Engineering Company. I worked for them. I have not been in [fol. 1749] responsible charge of any other large dams or reservoirs. We had some fairly large storage at one reservoir in Canada. As to whether I personally designed and constructed it, I was in charge of hydro-electric problems and features. That was the High Falls Dam on the Michipicoten River. Harza Engineering Company was the consulting engineer on that project.

It is true that many impounding reservoirs have sluiceways at least up to the capacity of the turbines, so that if the turbines are shut down for any reason, an equivalent amount of water which would normally go through the turbines can be released in order not to interfere with regulation down stream. As to whether it is a fact that the combined discharge capacity of the sluiceways and turbines at the Radford power project on the New River in proportion to the area of the reservoir is very much greater than the combined capacity of the sluiceways and the turbines at Norris in proportion to the area or volume of the reservoir, I don't know what the capacity of the sluiceways is at Radford. I know that the turbine installation there is very much higher in proportion than the turbine installation at Norris. I believe they are both 100,000 kilowatts, if I remember, and Radford is a good deal smaller reservoir than Norris. It has storage capacity of around 100,000 acre-feet. In other words, it is a great deal more highly developed for power purposes than Norris.

Examination by the Court:

That is shown by the power capacity of the turbines with reference to the size of the reservoir.

[fol. 1750] Cross-examination continued:

"Q. You also stated, I think, that downstream, the TVA projects had special features in that the spillway capacity is designed to carry maximum floods, is that substantially right?

A. What I stated was that there was more spillway capacity than would be required to pass the maximum estimated flood, in order to hold the reservoir down to a low level; in other words, the limiting factor there is the amount of water that could be passed over the low sill with a low reservoir level rather than the capacity of the spillway to discharge a flood of higher level.

Q. Will you tell me the maximum capacity of the spillway at Wheeler Dam?

A. At Wheeler, I think——

Q. Give it at minimum pool level?

A. Well, at Wheeler that relation does not obtain. The capacity at low pool level at Wheeler is rather moderate.

Q. Well, what is it?

A. I was seeing if I could recall what that is; I don't have the figure with me.

Q. Isn't it less than 200,000 second feet?

A. At what elevation are you referring to, elevation 48?

Q. What is that?

A. Elevation 548 or 550, or what elevation are you referring to for pool level?

Q. What do you think is the minimum pool level at Wheeler Dam?

A. 548 is what has been stated.

Q. Well, take that figure, isn't it true that the maximum capacity of the spillway at that level is less than 200,000 second feet?

A. I think it is around there. I would have to figure it, and I don't have a slide rule with me.

Q. Isn't it your recollection that that is about right?

A. Well, if it figured out that way, that would be about right. As I say, I cannot keep all of the figures in my head, I rely too much on the slide rule. That sounds somewhere around the proper figure, either 48 or 50 elevation.

Q. What is the maximum estimated project flood at Wheeler?

A. I believe it is 680,000, if I remember correctly. It is right around that."

[fol. 1751] I am familiar with the Blue Ridge reservoir on the Toccoa River. I think it is correct to state that the ratio of the Blue Ridge turbine and discharge gate capacity is greater in proportion to volume than at Norris. Blue Ridge was built for a high capacity peaking plant, and the power there was developed to the maximum. There has been no such development at Norris compared with the size as there has been at Blue Ridge. I do not know what the water capacity of the sluiceways and turbines is, but I know the turbine capacity and power is very high. I do not know that the sluiceway capacity at Blue Ridge is greater than the turbine capacity. Good, sound engineering practice on any hydraulic project requires that in the case of a power reservoir, a spillway shall be built large enough to take care of the largest estimated flood, far in excess of anything that had occurred in the past. That is good, sound engineering on any project. As I pointed out, at Pickwick and Gilbertsville we have gone in excess of that. At Pickwick we added two gates, and at Gilbertsville three additional gates beyond what we had estimated as the maximum possible flood. The provision of spillway capacity to meet these projected 500, 1,000 and even 5,000 year floods is a safety matter under proper hydraulic design and construction of a large dam with a large reservoir. You should go to the greatest possible limit on that; and if you provide beyond that, as we have done, it is for another purpose. Such spillway capacity is one of the things that is required by the Federal Power Commission and the Corps of Engineers in approving a project by a private company for the construction of a reservoir on a navigable stream. They are always vitally interested in that feature.

I stated that in each instance we have either placed the lock, or our plans for contemplated projects call for placing the lock at the opposite end of the dam from the power [fol. 1752] house. That is nothing more than common standard practice in the construction of any power reservoir or dam on a navigable stream. I have never known of the Federal Power Commission or the Board of Engineers approving a license for constructing a power project by a private company on a navigable stream with the power house placed alongside the site selected for the lock by the Corps of Engineers. I do not think it is good practice

and I do not believe they would allow it. I would not expect any power company building a power project on a navigable stream to do that or to be permitted to do that by the Corps of Engineers and the Power Commission. As a matter of fact, when you go up the Tennessee River to Hales Bar Dam, built many years ago, before the adoption of the Federal Power Act, the lock is at one end of the dam and the power house at the other. There is nothing particularly unique about that feature, except that the requirements for navigation were observed. That is observed in the same way that a private company asking a license from the Federal Power Commission would observe it.

I stated about the desirability of constructing Wheeler and Norris, which are above Wilson. The construction of both of those projects would very greatly increase the firm power capacity at Wilson Dam, and the value of Wilson Dam as a power project. I also stated that I thought it wise to construct Pickwick Landing Dam. The construction of the Pickwick Landing Dam also increased the firm power capacity for utility uses at Wilson Dam and made Wilson Dam more valuable as a power project by making possible peaking to meet a characteristic utility load.

When I studied this matter, I found with very little study that the two largest centers on the Tennessee River for manufacturing or commercial business were Chattanooga and Knoxville. Up to this date it is true that the TVA has never provided any practical, usable, navigable channel between Knoxville and Chattanooga, but of course the Chickamauga Dam is the initial step toward that. Outside of that we are working on the Watts Bar and Coulter Shoals projects; but I believe for the development of the Tennessee River that the most important thing is the outlet to the inland waterways system of the country, rather than the improvement of an isolated stretch which simply goes between two towns and nowhere else. As to whether it is my judgment that the wise and orderly development of a navigable waterway does not as quickly as possible connect the two largest cities and the two largest sources of potential traffic on the waterway, I do not agree that they are the two largest sources of potential traffic. You might have rail connections along the river, such as at Guntersville or Decatur, and leading into industrial areas in the hinterland which would have a larger potentiality

than two towns immediately on the river, perhaps. It is not my judgment that the future of Guntersville as a great commercial and industrial center is greater than that of Chattanooga and Knoxville. I said larger communities removed from the river, but in the hinterland. You have Birmingham and Gadsden and Attalla, and other towns readily connected with the river that may furnish commodities in excess of what you would find in an existing large town.

“Q. You testified as to your knowledge about the difficulties of building high dams after low dams had been constructed. I invite your attention to this statement of General Pilsbury, who is a very eminent navigation engineer, is he not?

A. Yes, sir.

Mr. Fly: I object to any cross examination on General Pilsbury's statement.

Judge Allen: The objection is sustained. The Court adheres to its ruling in that particular. You may have your exception.

Mr. R. T. Jackson: May we have our exception, and may I have my question appear in the record, so that I can show what is sought to be elicited?

[fol. 1754] Judge Allen: The record may show that Mr. Jackson desired to read from the witness testimony of General Pilsbury—

Mr. R. T. Jackson: Who the witness testified is an eminent navigation engineer.

Judge Allen (continuing): —who is not here and is not a party to this case, and the Court holds this is not competent examination. You may have your exception.

Mr. R. T. Jackson: And we are not permitted to show the statement which we wish to confront the witness with?

Judge Allen: You are not permitted to read into the record the testimony of General Pilsbury in another case, and you have your exception to that statement.

Mr. R. T. Jackson: Thank you. He is one of the chief—

Judge Allen: The Court is desirous of going forward with this case. We are required by statute to expedite the case. We have made our ruling and it stands.”

As to whether I have made studies to show at what elevation Norris reservoir would have to be on January 1, February 1, March 1, April 1, April 15 and May 27 in a dry year like 1925 in order to carry out the provisions of Water Control Bulletin No. 2, you will have to show me what Water Control Bulletin No. 1 is. Water Bulletin No. 2 of June 30, 1936, included in Complainants' Exhibit 933, says that until further notice water shall be released from Norris Reservoir, so as to maintain as nearly as may be a constant flow at Florence, Alabama, of 15,000 cubic feet per second. I don't know what elevation Norris was at that time. Apparently, the purpose was to maintain the 15,000 as long as possible. I don't know whether they had enough storage at that time to maintain it in an extremely dry year or not, and I cannot answer the question as to what elevation Norris should be on those dates you have given in order to provide that flow in a dry year. As I say, I think that figure was sought to be maintained as long [fol. 1755] as might be according to the bulletin. I did not furnish any figures for that, and I have not made calculations as to what the reservoir should be on those dates.

As to whether in my examination I found that the Dandridge site on the French Broad River would give much more storage than Hiwassee for flood control, I have never been satisfied as to the Dandridge site. I do not know how much storage might be obtained there. The reason for that is the foundation conditions are very bad, and the area is full of sink holes, and we have never determined whether a dam could feasibly be built there, or if it could be built, how high. I have examined the site physically and topographically several times, and have usually come to the conclusion that it was a pretty bad site, and we couldn't do anything about it without extensive drilling and investigations which we have never had the appropriations to carry out.

As to whether I found from my investigations that the Dandridge site on the French Broad would give much greater storage capacity than Hiwassee for flood control, I said we had never determined how high we could build a dam at the Dandridge site on the French Broad River, and the storage depends on how high you can build a dam. My answer is that we have never determined that it would have more. There are some sink holes at the Norris site,

removed some distance from the abutments, and there are sink holes upstream in the reservoir; but at the Dandridge site, you just step off of the abutment right into a sink hole about 50 feet deep.

Space is being provided at Hiwassee for the ultimate installation of two 60,000 kw. units, and one 60,000 has been authorized. Whether the second unit will be as large as 60,000 kw. or not will probably be determined whenever the need for it may become apparent. If it is, then the turbine installation will be much larger in proportion to the storage capacity of the reservoir than at Norris.

[fol. 1756] Referring to Defendants' Exhibit 151 where I have combined figures from various previous exhibits offered by me, in computing what I called flood storage, I did not make any allowance for slope in the pools, as that in a way automatically corrects itself. Those are flat pool levels, but we have found from an investigation of one or two reservoirs that although the slope in the upper level is less naturally than the slope in the lower level for the same discharge, the fact that a much larger area is occupied at the upper level in both cases has brought our calculations out, if I remember, to a fraction of one or two per cent of what it would be, taking the actual slope lines. So, we have for simplicity simply used the flat levels. The flat level without any slope is the basis of these calculations, but they are practically the same results that you would get if you figured these slopes. We tried it out on two jobs, I believe Gilbertsville and Chickamauga, and it came out as closely as it could be calculated, you might say within the accuracy of a contour map. I might explain another thing which makes that variable. That is, if you start with a certain flow on the lower level and end up with a certain flow on the high level, that would probably never be the same in any two floods. So you would have a constantly varying quantity, and this quantity is about what it would be under any actual conditions, and is much simpler to use.

I previously testified that it was sometime in July or August of 1937 that the conclusion was reached that the height of Gilbertsville Dam should be at elevation 375. No official action had been taken at that time, but the conclusion of the Engineering Department and the consulting engineers was that it should be not less than 375. That conclusion was made as early as the latter half of July by the Engin-

eering Department and early in August by the consulting engineers.

[fol. 1757] The document (offered and received in evidence as Complainants' Exhibit 925) was prepared by me, or under my direction. In the case of Gilbertsville that is, I take it, 359. That was the so-called normal pool level. It was not the surcharge level that is shown on there. You notice that is just a dotted line, while the others are solid lines. These are all in Watts Bar and Coulter Shoals which is also a dotted line. Those are with the old normal pool levels at that time. Gilbertsville is the old normal pool level. None of those show the surcharge level. That is dated July 9, 1937 and was approved by me some time after that. It bears my signature in the lower left-hand corner. But that simply shows the so-called normal pool levels and not the surcharges in those three cases.

The photostat marked for identification as Complainants' Exhibit 926, which is marked "page 10" and which you say follows Complainants' Exhibit 925, I have never seen before. I would not call Complainants' Exhibit 925 a design. There is a dotted line on there. I don't think it does correspond with the figures shown on Complainants' Exhibit 926. This maximum lock lift here is 68 feet, while according to this the lock lift would be 57 feet, so this is apparently 11 feet higher than that. I don't see any pool levels on here. The only thing to go by is 68, and I know the level below the 68-foot lift. That would make elevation 70. It would probably be somewhere between 70 and 75 at that lift. So the two don't correspond. As to whether page 403 of Complainants' Exhibit 116 does not show that early in 1937 the lock lift at Gilbertsville was 68 feet, I was trying to see whether it gives the pool level on here anywhere. As to whether I can tell from the acre-feet that the elevation was 370, the acre-feet might have been very close at that time. That looks like about 370 elevation; that is correct, 68 plus 302 pool level would be 370. There is a table here somewhere [fol. 1758] on those projects. I do not want to search further. I just thought it would make a better all-around check if I could find any other statements on Gilbertsville. This appears to be that old 370 elevation which does not correspond with that profile which you have showed me. As I explained, the profile shows the so-called normal pool level and not the surcharge. The old 70 refers to surcharge.

Referring to page 919 of the report of the Hearings on the Appropriations Bill for 1939 (which appears in the record as Defendants' Exhibit 153) that shows the lock lift for Gilbertsville at 68 feet, which is elevation 370. Looking at Complainants' Exhibit 926 for identification and page 403 of Complainants' Exhibit 116, it is true that for Gilbertsville there is shown the same volume of storage. It is obviously the same pool levels with a 68-foot lift.

As to my saying that I could not identify this sheet, Complainants' Exhibit 926 for identification, I said I did not make it up and had not seen it before. After I was on the stand before, I examined the data submitted to Congress in support of the TVA's recent application for an appropriation. But I did not change one of my volumes that was favorable to me at Wheeler the next day on the basis of the figures in that document. I explained that once before, that that was a misreading of the curve that I had had for several years, and it was a mistake in reading that curve, and I did not see the information which you allude to.

I have not checked up yet whether it is a fact that in the information submitted to Congress by TVA two days before I testified, I found that the volume of flood storages reported to Congress were different and less, not only at Gilbertsville, but at practically every other reservoir of TVA. I might say in explanation of that at Gilbertsville, which I [fol. 1759] found and checked up later, was that there was what was considered to be an insignificant change, in view of the status of the project, and it was not officially settled at that time that the final elevation was to be 375, and in view of that, rather than change the figures to the Appropriations Committee, and then later change them again, the old table was used, so as to avoid continual changes on a project still under investigation. That is the explanation which has been given to me for Gilbertsville.

As to whether I found in every case the report submitted to Congress two days before I testified showed a different and smaller volume of storage at the TVA reservoirs, I do not know whether it was every case or not. I suspect that they used flat pool levels in compiling that rather than the minimum navigation level which we have. As I say, I did not make up those tables and they were made up by some other person. The figures were in existence at that time. It was simply a case of different persons taking two different

figures. I usually make these up, but I did not this year because I was down here as a witness in this case. I approved the chart that you showed me in it, and as I stated, that simply gives normal pool level and not surcharge. I can not state definitely, but according to the best of my recollection that chart was made up for other purposes and inserted in the data which went to Congress. I may be wrong, but my recollection is that that was made up for another purpose and used later for that purpose.

I am head of the Project Planning Division. I have seen schedules similar to the document (marked for identification as Complainants' Exhibit 927) which is entitled "Tennessee Valley Authority Proposed Program of Dam Construction", which you say was also submitted to Congress two days before I testified. This is dated November 26, 1937, and is [fol. 1760] apparently put out by the TVA. I would have to study it over and check it up. As to whether I can not identify it, although I am head of the Project Planning Division, the thing of it is that this is set by the budget officials and the construction division—not by the planning division. I am asked at times with reference to these different projects. This is a schedule of construction progress rather than planning projects. The figures in the table on page 948 of the recent Hearings before the Appropriations Committee on the Bill for 1939 under the heading "Proposed Construction Schedule as of December 13, 1937", listing completed dams, dams now under construction, and proposed dams, seem to check with the construction schedule shown in Complainants' Exhibit 927. As to whether or not, as planning engineer, I have to know the construction program in order to prepare my plans and designs, I do not prepare the designs. I prepare preliminary designs, and then it goes to the designs division and they prepare the detailed designs. In other words, the detail of my work, except for seeing that certain hydraulic features are carried out, is usually finished, perhaps a year or a year and a half or two years before the project starts, and after that it is simply a follow-up process.

(The witness was excused.)

[fol. 1760a] The depositions of the witnesses R. D. Cowley and K. T. Hutchinson, taken by complainants and offered —

by defendants were ordered by the Court to be included with defendants' case.

(The deposition of R. D. Cowley is as follows:)

R. D. Cowley was called as a witness on behalf of complainants and, having been first duly sworn, was examined and testified as follows:

Direct examination:

(Offered by defendants and admitted by the Court over complainants' objections set forth at side folios 638 to 641, inclusive, supra.)

I am 51 years old, was born in Lincoln County, and my address is Kelso, Tennessee. My home is on a farm about eight miles east of Fayetteville, in Lincoln County, Tennessee. I am a farmer, grain dealer and banker. I am President of the bank at Kelso and I have a grain warehouse, but I would not consider it an elevator. I have lived in Lincoln County all my life and I am Secretary and Treasurer of the Lincoln County Electric Membership Corporation, a Tennessee corporation, and I have held that position since the Corporation was organized. The original incorporators were B. E. Holman, M. F. Childress, D. L. Conger, George Goodrich, W. W. Gill, J. A. Stewart, and myself. Mr. Conger is President, Mr. Childress and Mr. Gill are Vice Presidents, and I am Secretary and Treasurer. Mr. Conger is now away on a vacation trip. I do not know what date Mr. Conger left. He was at our last meeting on July 7th and said he was going to take a trip and would start within the next day or so.

As Secretary and Treasurer of the Corporation, I have the custody and possession of the minute books, the charter and by-laws of the Corporation. I have here with me the [fol. 1760b] by-laws and certificate of incorporation, and the minute book of the Corporation.

I have a copy of the certificate of incorporation dated September 12, 1935, granted the Lincoln County Electric Membership Corporation. I did not bring the original.

"Q. Do you have the custody and the possession of the original certificate?

A. Yes, I think we have that in my files at home.

Q. Will you produce and file as complainants' exhibit for identification No. 26, Cowley, the original certificate of incorporation?

A. Not without direct authority and instructions from my lawyer, Mr. Holman."

Certain paragraphs from the minutes of the first meeting of the incorporators of the Lincoln County Electric Membership Corporation, held on September 16, 1935, read as follows:

"There was also present at the meeting Harold F. Clark, of Athens, Alabama, and J. M. Peavey, of Fayetteville, Tennessee, both representatives of the Tennessee Valley Authority, who met with the Board and explained many details necessary to the proper organization of the company."

• • • • •
 "Thereupon, upon motion of M. F. Childress, duly seconded by W. W. Gill, it was ordered that one of the Tennessee Valley Authority attorneys be requested to assist B. E. Holman, and J. M. Peavey, in the draft of proper by-laws to be submitted to the Board at a subsequent meeting, for approval, all present voting for the adoption of this motion.

Two letters were then read from Mr. F. F. Beauchamp, division engineer, informing the Board that on Tuesday, October 1, 1935, twenty-three miles of rural lines now constructed in the southwest corner of Lincoln County, between Giles County, and Huntsville Highway in Lincoln County, would be energized."

In answer to whether those three paragraphs read by me correctly set forth what happened, if they had been incorrect they would not have been put in the minutes. I have no recollection now of what happened—there were too many [fol. 1760c] details for me to remember—little things two or three years ago. I tried to keep the minutes correct.

Certain paragraphs from the minutes of the meeting of the Board of Directors of the Lincoln County Electric Membership Corporation held on September 26, 1935, read as follows:

"Mr. J. M. Peavey and C. G. Davidson, attorney for the Tennessee Valley Authority, met with us and gave valuable advice in outlining the methods by which we should proceed."

"The Witness (interpolating): I might also add that these gentlemen appeared at the request of the Lincoln County Electric Membership Corporation."

"A suggested form prepared by Mr. C. G. Davidson, attorney, to be used in application for membership in this corporation was presented and the same is herewith filed for further reference, and

The power contract between the Tennessee Valley Authority and Lincoln County Electric Membership Corporation was presented, the same as prepared by Mr. C. G. Davidson, attorney, and said contract is in words and figures as follows."

(The power contract and the sale and security contract between the Lincoln County Electric Membership Corporation and TVA referred to in the minutes and produced by the witness were never actually delivered or placed in operation. Up to December 11, 1937, the properties were operated under agreements described below and identified as Complainants' Exhibit 588 and Complainants' Exhibit 626. On December 11, 1937 these agreements were superseded by a new contract subsequently received in evidence as Defendants' Exhibit 144.)

The Lincoln County Electric Membership Corporation had a contract with TVA dated October 1, 1935 (which appears in the record as part of Complainants' Exhibit 588) for the collection of bills for electric services, which contract has been renewed. The Corporation also has a supplemental contract with TVA dated June 29, 1936 (which [fol. 1760ca] appears in the record as part of Complainants' Exhibit 626) for the collection of bills for services.

I don't know the exact date when the TVA began the construction of lines in Lincoln County. Our first meeting ap-[fol. 1760d] pears to have been held on September 16, 1935, and our charter bears the date of September 10, 1935. The construction of those lines began considerably prior to those dates. I don't remember how long before the certificate of incorporation was applied for that the lines were begun.

There were 23 miles of lines in process of construction, as I recall, at the time the Corporation was formed, but as to whether or not those lines were still under construction at the time of our first meeting, I would have to look at the records before I could say.

There are no other contracts in existence that I know of between the Lincoln County Electric Membership Corporation and TVA other than the contracts I have produced. There are approximately 159 miles of line in Lincoln County now in operation by TVA. TVA is operating those lines at our request. The Lincoln County Electric Membership Corporation has not taken over these electrification lines and is not now contemplating so doing. Since the formation of the Corporation, TVA has operated those electric lines at our request.

I do not know exactly how many miles of lines are yet to be built. About 680 customers are now being served by the lines which are in operation. The lines are scattered through a good part of the County, not in every section, but pretty well scattered. As to who determined where those lines would be built and the details incident to their construction, I don't know as I can say with reference to other parts of the County, but I can intelligently answer with reference to the section of the County wherein I live. Our contract with TVA shows that the Membership Corporation has three methods of paying TVA for the lines it had constructed, either by paying for them in cash, part in cash and part in notes, or all by notes. In either event when notes were executed, they would be secured by trust deeds on the properties and we would pay interest on any unpaid [fol. 1760e] balance of the principal sum at the rate of $3\frac{1}{2}$ per cent per year, with interest being paid semi-annually. I do not know what the lines now constructed and in operation have cost, but I have requested a bill for them. I do not know the cost of the lines which it is contemplated will be built. At the present time I don't know what would be the actual cost of the lines when they are all completed or how much the Corporation would have to pay TVA for the lines when the Corporation takes them over. I called for that information on July 7th, but my understanding is that our operating contract with TVA expired June 30, 1937, but TVA continued to operate the lines. The contract has a proviso covering the lapse of time between the time the contract

expires and the date that it may be renewed. The employees of the Corporation consist of a young lady in our office, a superintendent and two linemen that are employed more or less regularly, as I understand. That is a part of the duties that TVA had to assume, because we are under an operating contract and I would not be supposed to know exactly the number at all times. As to whether I know the names of those employees, I know the name of the girl, Miss Morris, Mr. Campbell, and I believe there was one by the name of Mr. Moore, if I am not mistaken. Let me explain that that is being done under our contract with TVA whereby they are operating at our request and for that reason I cannot definitely answer. TVA pays the salaries of those employees under our contract with them. The bills for electric service rendered to customers are payable to TVA in line with our contract.

As to who determined where the lines were to be built in the section where I live, we first made a potential survey of the various roads leading into the little town of Kelso and marked off on the roads the number of the various dwelling houses which we thought would purchase current and gave this information over to our committee in Fayetteville, with [fol. 1760f] the request that it be worked out where the greatest number of people would be served. I could not say as to who determined whether or not the line to that community would be built. This information was given to our committee which was earnestly insisting on TVA to construct these lines for our proposed organization, and just how this committee worked it out with TVA I am unable to say, but there was no road in our community that they were not insisting on a power line to come along and were not satisfied if they didn't get it. We had some difficulty with TVA in getting the lines built, by reason of the fact that I own a rather large farm and a Mr. Douglas just across the river also owns a very large farm. These particular roads were rather thinly populated and the Membership Corporation did not see fit to recommend the construction of those lines just because we would take current, without a specific knowledge of the amount of current that we would take and pay for. I don't know that it was necessary for me to go to Chattanooga and take the matter of extending service to my community up with TVA. I made my trip to Chattanooga after these lines were under construction. I

did make a trip to Chattanooga with reference to some other lines. I said a few days ago that the purpose of my trip to Chattanooga was to get service to my community, but I was talking then and I am swearing now. I told you then that these lines were not going to be built because there was an insufficient consumption of current to justify the building of the lines, and that therefore I went to Chattanooga to discuss the matter with TVA, but I was mistaken and I meant to tell you that I made my trip to Chattanooga for a work order, after the lines were ordered constructed. Some three or four other customers on that line and I are underwriting a definite amount of power to be consumed, but we are not obliged to do it for the reason that my neighbors and myself consume more of our requirements than we did, and [fol. 1760g] we think we can apportion it entirely within our radius. Naturally we had a certain amount to guarantee and certainly it would not have been good business for them to have constructed four or five miles of lines to just give service to four or five customers.

[fol. 1760h] Cross-examination:

(Offered by defendants and admitted by the Court over complainants' objections set forth at side folios 638 to 641, inclusive, supra.)

I have lived 51 years in Lincoln County and for the past fifteen years I have been generally familiar with the extent and nature of electric lines and electric service in the County and in this area.

"Q. Mr. Cowley, during this period for the past fifteen years what has been the situation in the rural areas in this County with respect to the existence of electric lines and electric service?

Mr. Snapp: I would like at this point to object to this question and to any other questions of that nature for the reason that they are beyond the scope of the examination in chief.

The Special Master: I rule that I do not have any power to exclude the testimony and I overrule your objection and you may take an exception.

Mr. Snapp: Yes, we note an exception.

By Mr. Fitts:

Q. Just proceed.

A. The rural sections of Lincoln County, and especially the section of the county wherein I reside were denied the benefits of electricity and were unable by any reasonable means to procure same.

Mr. Bemis: I think the answer is improper and should be stricken out, this statement, that his community was denied the benefits of electricity, that that is a mere conclusion of the witness.

The Witness: I will change that and say that they could not secure the benefits.

The Special Master: I will overrule the objection.

Mr. Bemis: We note an exception."

I had made an effort in my community a number of times to secure electric lines and electric service in the rural areas by taking the matter up with the local manager of The Tennessee Electric Power Company and once by [fol. 1760i] making a trip to Shelbyville with a delegation of citizens of Kelso and Fayetteville to confer with Mr. Tom Greer. The electric lines run east to a farm which we know as the Jesse R. Smith farm, which adjoins real estate now belonging to me and which is only two or two and a half miles from my home. At one time I wired and asked permission from the Power Company to construct my own line at my own cost, by digging the holes and furnishing the poles and the wire, and asking if they would furnish the service, and they refused. I know of my own knowledge that in 1933, and 1934, and the early part of 1935 there was a desire among the membership of the rural area in this section for electric service. I know of my own knowledge of other demands by people in this County to procure electric service during the period of 1933, 1934 and 1935, by reason of having talked with community leaders who are interested in these extensions for the benefit of themselves and other communities, and by having our organization meetings from time to time and by conferences with a great many men,—I guess you would call it that, large numbers of citizens would come together at least here in Fayetteville from different sections of the County who were interested and so much interested in

securing electric rural lines to their homes and their communities. Before the first line was built anywhere in the rural areas in this County by the TVA, the Corporation or anyone else, I made an attempt to get these lines built by TVA, although I was not doing work at that time in the community but some of my associates were. I went to the County Court and to the Farm Bureau of Lincoln County in behalf of securing these electrification lines, and especially to Major Childress who was a court member in the County. In answer to under what circumstances and about when I first heard about and became connected with a movement for the purpose of building these lines, as [fol. 1760j] I recall I was asked by numbers of people—you understand now that it is rather hard for me to remember back and tell the exact details of things. I recall Mr. Lawrence Sloan, now deceased, who at the time was President of the Lincoln County Farm Bureau, told me that there was a proposition being prepared which would be presented to the County Court to get TVA to construct the lines and sell them to us in this county. We approached TVA and solicited them very urgently.

I am fairly familiar with the location of the rural lines in this County and I do not think there are any lines duplicating or paralleling the lines belonging to any private power company. I know there was no line for service to Kelso, Flintville, Elora and other sections of the County, and neither were there any lines servicing Boone's Hill, Coldwater, Malina and a number of other points in the County. Not to my knowledge were any of the 680 customers of the Corporation previously served by any private power company. I know that a great many were not served,—I would think 100 per cent of them were not served. The surveys along the road which I spoke of in my direct examination were not made by surveying instruments but by people getting in cars and going along the road and marking out this house or that house. In our community that was done by John Taylor,—he is now deceased—and by one or two others. In the beginning of the matter and no part of this was connected with TVA in any way or the Electric Membership Corporation. The cost of them was paid for by private funds. As to whether in gathering our information we solicited customers for the Corporation who could be induced to sign contracts, we did not. At that

particular time we were making surveys so that we could submit information to our committee as to approximately how many customers would be served. When we had this information we turned it over to our committee, or to [fol. 1760k] Mr. Sloan who was President of the Farm Bureau.

We have a contract with TVA by the terms of which these lines that have been completed by the TVA at its own cost are to be sold to the Corporation. When these lines will be turned over to the Corporation will be determined by the Board of Directors and the Committee,—the Board of Directors and the Committee being at present one and the same. TVA will be obliged to turn these lines over to us under the contract when we make the election. At the present time, these lines belong to TVA and are being operated by TVA under the existing operating contract, the revenues are being collected by TVA, and the employees engaged in the operation are employees of TVA. As a member of the Board, I think I am familiar with the general plans for the operations when the lines are turned over to the Corporation. Our Board has discussed informally the plan of operation which will be put into effect when we get these lines. The general method of operation is described in the contract between the Corporation and the TVA.

“Q. On the basis of your familiarity with the matter and your knowledge of the terms of the agreement of the Corporation and the Tennessee Valley Authority do you think you could answer the question,—

A. (Interposing.) I think I can.

Mr. Bemis: The question calls for the conclusion of the witness on that subject.

The Special Master: It is overruled.

Mr. Bemis: We note an exception.

Q. Based upon your knowledge that you spoke of, when the Corporation assumes these lines and the title to the lines is passed to them, how will the bills be collected and how will the checks be made, and how will the employees be paid, and whose employees will they be and how will the lines be operated in general?

Mr. Bemis: I make the same objection to that question.
The Special Master: It is overruled.

[fol. 17601] Mr. Bemis: We note an exception.

The Witness: The checks will be made payable to the Lincoln County Electric Membership Corporation who will make collection of all bills and the employees will be employed by the Board of Directors of the Lincoln County Electric Membership Corporation and will be paid by them upon the order of the Board."

I remember having a talk with Mr. Watson in reference to obtaining service from The Tennessee Electric Power Company prior to the date of the construction of these lines. I don't remember where the talk was—I believe perhaps in my office here in Fayetteville—I don't think I went to his office. The general subject of that conversation was in reference to securing current to serve our community. It has been so long ago that I can't recall the details of what I told him I would do in order to get that service, but I do remember that the requirements were such that our community could not comply with them.

"Q. To refresh your recollection I will ask you to state whether or not the substance was that you stated that you should build the line at your own expense to serve your requirements and the other customers to be served over it thereafter and that the ownership of the lines should be deeded to the company.

Mr. Bemis: I object to that because the witness has answered that he was unable to give the details.

The Special Master: He may answer.

Mr. Bemis: We note an exception.

The Witness: That conversation did not occur with me, but I did on or about the same time when I was trying to get current over there, tried to get Mr. Watson to consent to allow me to build my own line over which I would bring the current up to my home which is approximately two and a half miles."

I have spoken in my direct testimony of the meeting of the Board of Directors on September 26, 1935, at which certain representatives of TVA were present. My understanding and recollection is that they were present at our invitation and request, to aid, assist and advise us upon the problems under consideration, and give us the benefit of their own previous experience in any instances that might

[fol. 1760m] come up. Neither myself nor my associates, other than one of our incorporators, Mr. Holman, had any experience in forming and organizing an electric membership corporation of that character, but I understand Mr. Holman a number of years ago had some experience in electric lines by reason of being joint owner of a small plant in southwest Kentucky. At these meetings no statements were made which would have caused me and my associates to go out and take customers away from the Power Company. Any expressions always came from our own Board membership as to constructing more lines for us. The purpose of having these representatives of TVA attend the Board meeting mentioned was to outline the method of organization and the way in which we would go about setting it up, and to answer such other questions with reference to the organization as the members of the Board might request.

(Thereupon counsel for complainants received permission from the Special Master to examine the witness on matters he had testified to upon his cross-examination without waiving objections as to the scope of the cross-examination.)

Redirect examination:

(Offered by defendants, and admitted by the court over complainants' objections set forth at side folios 638 to 641, inclusive, supra.)

In answer to whether or not the demand and interest and desire of the people in the county for electricity was in any way affected by the TVA and the low rates offered by TVA, so far as I know, and I am now speaking for myself. I was always interested in it and had been for a number of years.

[fol. 1760n] "Q. Was not your interest as a resident of Lincoln County in rural electrification accentuated after the advent of the Tennessee Valley Authority, and after the mass meeting and the organization meeting, etc.?"

A. That was where the contract started, was at those meetings.

Q. (Interposing.) I am simply asking you was it before or after?

A. It was when the Tennessee Valley Authority had been created by act of Congress."

In the local meetings and in the mass meetings that met with the county agents, Mr. Sloan and Major Childress, the rates of TVA were not discussed so much as the fact that we could get electricity which we had had trouble in getting and the fact that TVA would build the lines and that we could get it at all. The rates were not discussed so very much but it was discussed that they were needing it. I was interested in securing it for myself, but I cannot tell what other people thought. I wanted electricity before I died and I wanted it so I could enjoy it.

As to whether anyone has talked to me since Saturday regarding my testimony, I talked with Mr. McFarland a few minutes last night and with Mr. McFarland and Mr. Fitts about three minutes this morning. I talked with Mr. Fitts in Mr. Holman's office not over five minutes.

(The witness was excused.)

[fol. 1760o] (The deposition of K. T. Hutchinson is as follows):

K. T. HUTCHINSON was called as a witness on behalf of the complainants and, having been first duly sworn, was examined and testified as follows:

Direct examination:

(Offered by defendants and admitted by the Court over complainants' objections set forth at side folios 638 to 641, inclusive, supra.)

I am 42 and reside in Murfreesboro, Tenn. I am President of the Middle Tennessee Electric Membership Corporation and also Professor of Agriculture at the Middle Tennessee Teachers College at Murfreesboro, and Director of the farm at the College.

I received a notice on Saturday morning to come here and produce copies of a letter dated May 4, 1936 from L. A. Sears, a letter dated May 8, 1936 from W. I. Nichols, and a letter dated June 17, 1936 from K. Wilde Blackburn, Asst.

Counsel for the REA. I do not have those letters. Since that time I have made a search through all our files and I have not as yet been able to locate them, and I am sure I do not recall at this time the nature of the letters. At the time these letters were written we had no office. We established an office about September and it has come to my attention that our files have been searched and also that there have been photostatic copies made of quite a lot of records in the office, and I am not sure as to where these letters are. However, I have a hunch that copies of these letters can be secured from Mr. Blackburn and that they may be filed with him but I am not sure.

With reference to the photostatic copy of the letter dated May 4, 1936 signed by L. A. Sears, Chief Project Section of REA, I could not testify that I received that [fol. 1760p] letter. I do not mean to say that I did not receive it, but I mean to say that I don't know. At the present time, I do not recall having received it.

With reference to a photostatic copy of the letter, addressed to Dr. K. T. Hutchinson from K. Wilde Blackburn, Asst. Counsel, % TVA Legal Division, Knoxville, Tenn., dated June 17, 1936, together with an attached form, I do not remember receiving such a letter. I do not recall whether or not I received that letter. I have not since Saturday personally searched the records of the Corporation for these letters, but I have had our proper employees make such a search as would be justified. I have no files at home because any such matters would be at our office.

Some of the letters which have been referred to and which I have been asked to produce I recall receiving, but such letters were immediately delivered to our Corporation office. I have established no office whatever at the College or at home.

As to whether at any time I procured and furnished to Mr. Blackburn a certified copy of the charter of incorporation of the Middle Tennessee Electric Membership Corporation, that has been the work of our counsel, Mr. McFarland. I have not personally mailed certificates of the recording of the charter in various counties wherein the Corporation is operating to Mr. Blackburn, and I could not swear that they have been furnished to him.

(Mr. McFarland then conceded that he had personally made certified copies of the certificate of incorporation in

the different counties covered by the Corporation and had personally mailed them to Mr. Blackburn.)

As to whether the permit from the State Highway Department of Tennessee giving the Middle Tennessee Electric Membership Corporation the right to construct electric lines along the state highways has been mailed to Mr. [fol. 1760q] Blackburn, that has been referred to our attorney to handle in the proper way. The consents for the use of roads from the courts of the counties mentioned in the certificate of incorporation have also been referred to the attorney of the Corporation and I understand they have been furnished to Mr. Blackburn. I remember receiving a letter from Mr. Blackburn stating that he was enclosing a copy of a letter and asking me to hand the copy to Mr. McFarland as he did not know Mr. McFarland's address. I suppose I handed Mr. McFarland a copy of that letter, but I can't be absolutely positive about it. It has been my custom under this program to carry out my duties.

(The witness was handed a photostat copy of a letter.)

"Q. Now, with the slight refreshing of your recollection, I will ask you to read that letter or that photostatic copy of the letter at the concluding paragraph and see if it brings back to your mind any remembrance of receiving it? Does that bring back any recollection of the letter?

A. I don't say that it does."

With reference to a photostatic copy of a letter dated May 8, 1936 from W. I. Nichol, I must say that I do not remember whether we received such a letter.

Cross-examination:

(Offered by defendants and admitted by the Court over complainants' objections set forth at side folios 638 to 641, inclusive, supra.)

I am President of the Middle Tennessee Electric Membership Corporation and have held that position since its organization approximately in January, 1936. I have lived in Murfreesboro about ten years and previously I lived in Nashville. I am generally familiar with the rural areas in this County and the adjoining County. I own a farm

in this County. The Middle Tennessee Electric Membership Corporation operates in Rutherford, Wilson, David- [fol. 1760r] son, Cannon and Smith Counties. It has approximately 280 miles of transmission lines in operation and it serves approximately 706 customers. The lines are owned by the Corporation. They were constructed by TVA as contractors under contracts for construction work.

Mr. Bemis: We make the general objection that the question goes beyond the scope of the direct examination.

The Special Master: It is overruled because of the lack of authority on the part of the Master."

Under the contract, TVA was to be paid for the construction work by the Corporation on the basis of the cost, plus overhead, as set out in the contract. I think I am correct in saying that the overhead is 12½ per cent. The payment for construction work has been made in part. \$226,000 has been paid. The total obligation is \$275,000. The lines have been turned over to the Corporation and are owned and operated by the Corporation. They were never operated by TVA so far as I know. The Corporation's office force sends out the bills and the checks from the customers are made payable to the company. The Corporation at present has three full time employees and one part time employee.

As to whether I can tell you of my own knowledge the extent of the rural electrification service at the time the Corporation was first organized, in the counties in which the Corporation is now operating, before the Corporation lines were built, I cannot answer that in the matter of percentages but I can answer it from my general observation and as I knew it from my experience as a farmer. I have been Director of the local Farm Bureau and other activities of the farmers, and since I was familiar with their situation, I can say that many communities desiring electric service were not being served at that time. These communities had made efforts to get service. I first learned of the movement to get rural electrification in this community when it was talked among the farmers in 1935. My first real knowledge of a real effort to get service in this section was [fol. 1760s] called to my attention on the morning of the mass meeting of the farmers, when I was called at my office and urged to attend because of my interest in the farmers, which I did, and at that time the mass meeting authorized such procedure. Before the lines were constructed, the

people from these various communities represented at this mass meeting went back to their respective communities and took the matter up further with their people in the interest of rural electrification. We did not have the assistance of TVA or any of its employees, as the people who lived in the communities and attended the mass meeting were desirous for electric service and did the work themselves. The Corporation undertook to construct these transmission lines. I have referred to after the customers had signed up, which has been our policy throughout. The people went out who wanted service and signed up customers and then the lines were built to where the customers were. May I add that it was unanimous and that there are some communities that are desirous of service who have not as yet been accepted. The preliminary work was done absolutely at the instance of my associates and myself. We bore the expenses of the preliminary survey and of our travel long and short trips in the territory, and of our charter and its registration and we have not been reimbursed. In doing this work and in making this preliminary survey and in contacting customers, we were advised by TVA, after we had made the request for such information, that we could not serve customers already being served by another power company, so thereafter we did not contact such customers. This has been the policy of our Corporation from the beginning. In the first meeting of the Board of Directors, we talked it over and passed a resolution to that effect, stating that we would not in any way attempt to interfere with or disturb any power company that was rendering service in a community where we were active, and we also expressed in that resolution that we wished complete cooperation. I am rather [fol. 1760t] familiar with the list of customers receiving service from us and I think I am correct that there is absolutely not one who was previously a customer of the Power Company. The locations where our lines were built were not served at all prior to our service. Where other lines were already existing and rendering service, we did not undertake to secure customer contracts.

There are existing cases of duplication of lines where our lines are parallel or along the same road with the lines of the Power Company as they now stand. These lines of ours are parallel to theirs, because the private Power Com-

pany lines were built along these roads after our customer list was secured, and we had proposed to build these lines. Our lines were built for us after we had contracts with the customers along the road. I do not know whether or not the Power Company built these lines before or after we signed the customers. I stated a moment ago that our Corporation has adopted a definite policy of not soliciting any customers previously served by the Power Company, but I am under the impression that we have not received the same sort of cooperation from the Power Company, because in some instances when a list had been completed and signed up, customers have been served by the Power Company after they had signed up with us.

The Board of Directors of our Corporation determined whether or not we would build a line at a particular place or run a particular extension to a customer or group of customers, and we made that determination ourselves. I know what contacts our Corporation has had in the past six months with TVA or any of its representatives. These contacts have been only at our request when we have asked their advice in some detail matter, for example as to whether this particular undertaking may be economical and feasible, but it has been at our request all of the time. We have a regular meeting of our Board of Directors once a month and we may call special meetings in addition. Our Board [fol. 1760u] members are not paid any salary nor any expense money.

(Thereupon counsel for complainants received permission from the Special Master to examine the witness on matters he had testified to upon his cross-examination without waiving objections as to the scope of the cross-examination.)

Redirect examination:

(Offered by defendants and admitted by the Court over complainants' objections set forth at side folios 638 to 641, inclusive, supra.)

At times we would ask TVA for advice as to whether or not the proposed undertakings were economical and feasible. In a way TVA was at those times offering to help us and our counsel and render such advice and service, that is, after we prevailed upon them a while they might offer this sug-

gestion. We took up with the TVA such questions as related to our power contracts which we have with the TVA. We cannot secure customers except according to these contracts which we have with TVA. In reference to the power contract, we have asked other advice because we could not serve customers without the power.

"Q. Does that question depend upon whether the project under consideration is economical or not economical and feasible?

A. Well, as to whether our contract with them for power supply would hold good to render service to such customers.

Q. If I understand it then it covers other matters except those about which you asked advice, as to whether or not they are economical and feasible?

A. No.

Q. As to questions which might arise about your contracts.

A. Yes, with the Tennessee Valley Authority.

Q. And that is all?

A. That is all we have consulted them in regard to."

[fol. 1760u-a] I think TVA supervises our books and accounting under our power contract. That is they audit our books. My explanation is that to the extent our power contract with TVA calls for such attention to our books they supervise our books and accounting. I was a director in the local Farm Bureau of Rutherford County. I attended a mass meeting of farmers which was held in January, 1935, at the Rutherford County Health Unit and was the first of such meetings. I recalled some of the subjects discussed at that meeting. It was a farmers' meeting and they discussed their need of electric service and they pointed out how insistently they had striven to acquire electric service, but until that time had not been able to get it, and I know that it was the general feeling of the group that they were not [fol. 1760v] getting proper attention from the Power Company as to the then existing power service, that they were not getting proper consideration as to their getting power service. I don't recall any representative of TVA being present at the meeting. If there was,—I didn't know them,—and I didn't know by name all the farmers who were present. Professor C. F. Holt presided at the meeting and he is a farmer in this County. The meeting was in session when I arrived. I was notified of the meeting. Ramsey Snell, a farmer in this community, called at my home and requested

my wife to tell me to go. At that meeting I was selected as one of the persons who was detailed directly to proceed with the organization and with this effort to secure power from TVA, and after that meeting I attended other meetings. TVA employees attended later meetings at our request. I recall the names of some of these employees. Mr. J. M. Peavey of TVA present here in the room, is one; also Mr. Edward Falck and Mr. W. I. Nichol. I don't recall any of the others. There have been regular monthly meetings and some called meetings.

I judge that the farmers of this County and the adjoining counties found out about the possibility of forming an electric membership corporation and having TVA build the lines and the cooperatives borrow money from REA through their newspapers and from other sources of daily news. They did not know the details of this when they attended the meeting, but they knew something about it and that is what prompted them to attend their first mass meeting. I suppose the farmers saw that TVA power was available from the newspapers and I saw it myself. I approached TVA about the financing and building of the lines the first time after I had made my second trip to Fayetteville, when I looked up Mr. Peavey and talked to him about the possibility of securing such service. Mr. Peavey said: "I will, of course, let you have any suggestions that might be helpful", and he also emphasized to us that he was very busy [fol. 1760w] and did not know when he could give us any attention. Mr. Peavey discussed the matter with me further at other times. I have seen Mr. Peavey at the TVA office in Fayetteville. I have also seen Mr. Peavey at Shelbyville, after the TVA offices were there. I saw him with regard to our power contract and later in regard to our construction contract.

I believe that the thing that prompted the interest of the farmers in securing rural electrification was not entirely the TVA low rates but the desire and feeling of the need of electric service.

"Q. Now, I understand you to say that you do not believe that the low rates for power and the ability to secure money at $3\frac{1}{2}$ per cent interest had any effect on the people as to the interest in procuring these lines?

A. Well, of course, I cannot answer for other people as to what their feelings were that prompted their thoughts.

Q. But all of these meetings and the building of the line and the expense and the formation of the Corporation was after the Tennessee Valley Authority had come into Middle Tennessee, was it not?

A. No. As I understand it, there had been brought to my attention communities and individuals who had made efforts to secure electric power but were not able to do so.

Mr. Snapp: I object to that as being hearsay.

Mr. Fitts: He asked the witness for a conclusion, he asked him if it was based on the ability to get cheap Tennessee Valley Authority rates and the witness said 'no' and then he proceeded to say that he knew of such efforts before that time.

Mr. Bemis: Now, what has occurred appears on the record and we now ask that the record show that we move that the witness' explanation be stricken out.

The Special Master: I think that the witness more or less had occasion to make an answer of that kind at that time.

Mr. Bemis: We note an exception."

I have not known the County long enough to know whether the interest that was manifested at these meetings held by the farmers was after the TVA had come into Middle Tennessee and started its operations.

[fol. 1760x] **"Q.** What do you mean by saying that you 'had not known the County'?

A. Well, I mean by that I have been in this County only ten years as a citizen and owner of property and during those ten years I have been rather impressed in these various discussions with farmers, and that was before the Tennessee Valley Authority was every organized, to the effect that they had made diligent effort to secure electric service and they were not able to get it.

Mr. Snapp: We except to that statement of the witness."

The first meeting I attended towards getting rural electrification was in January, 1936. I cannot answer whether that was before or after TVA began its operations in Middle Tennessee. I do not know when TVA began operating there. At that time TVA did have an office in Fayetteville and I visited them there to get information.

I have lived in this County about ten years. I own property a short distance from the then existing Tennessee

Electric Power Company line and I asked that they view my case. I bought this property in June, 1932, and soon after that I went to the Power Company, to one of their officials, and asked that they view my case and give me some kind of an answer as to whether they could serve me or not and I never heard anything from them and later I learned,—this was before I ever heard of the Tennessee Valley Authority,—and I heard that the farmer directly opposite my property was undertaking to get service and I went back to the Power Company again and offered them a right of way across my property free of charge towards servicing this farmer and my farm which was directly across the road from this existing line to this community that they went through there to serve and I have never heard from it since. In answer to the question as to whether I made an application for extension of service to the Tennessee Railroad and Public Utilities Commission, I do not know about any other people but they did not supply me with any written form to fill out but simply ignored my request and have not made any answer to it yet.

[fol. 1760y] In making our surveys of customers in the community which we signed up, TVA did not furnish the forms that we used. Our attorney prepared the form we used and I cannot answer whether it was prepared from the one furnished by TVA. The surveys of the customers were not made prior to the formation of the Corporation. The general survey of our territory was made sometime before the mass meeting which set the organization going. In the early days before the Middle Tennessee Corporation was set up, Mr. Carmack was our attorney. He was elected at the mass meeting as one of the members of the organization when the Corporation was authorized. Mr. McFarland, our present attorney, began to represent the Corporation at the time it was organized. As I understand it, the form of survey that was used was prepared by Mr. McFarland. As far as I know, before the formation of the Corporation he prepared the form of survey. As far as I know he was our acting attorney at that time. Since this subpoena was served upon me I have talked to Mr. McFarland.

Recross-examination:

(Offered by defendants and admitted by the Court over complainants' objections set forth at side folios 638 to 641, inclusive, supra.)

I talked to Mr. McFarland once in his office and I guess we were in the office five or ten minutes. The first time that I saw him was about ten minutes before we appeared here today. No one connected with the TVA has told me what to say or what not to say in answering questions, and no one told me what to answer or specifically what to state in reply to any questions.

(The witness was excused.)

[fol. 1761]

OFFERS IN EVIDENCE

Counsel for defendants offered in evidence and the Court received as Defendants' Exhibit 153, the Hearings on the Independent Offices Appropriation Bill for 1939. Counsel for complainants objected to the offer on the grounds that the statements made by TVA representatives to the Appropriations Committee as set forth in said Exhibit were incompetent and self-serving.

"Mr. R. T. Jackson: If the Court please, the situation is that we had a little different view about the admissibility of documents, in the first place, than has been expressed by the rulings of the Court. In the first place, House Document 328 is the report of engineers in their official capacity, which, as we understand it, has been traditionally accepted by the Federal Courts as proper evidence.

When matters come before a committee involving facts that are in litigation with a citizen or with other arms of the Government, it is our understanding that their statements were admissible as admissions against them, but not in their favor. The Court adopted a different view of the latter class of documents, and held, as I understand it, that they were admissible in toto regardless of whether they might be admissions, or what we might claim to be self-serving statements.

Our only purpose here was, with the Court's permission, to preserve our position as a matter of evidence upon that type of documentary proof."

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"Judge Allen: The Court has decided to admit the statements in connection with the budget hearings and all matters

in connection therewith. Your objection on that point is overruled and you may have an exception.

Mr. S. D. L. Jackson: If the Court please, I am not quite clear as to the extent of the Court's ruling.

Judge Allen: The extent of the Court's ruling is that the entire statement, not only made by members of the Authority, and the colloquy between them and members of the Committee, but the speeches of Representative May, and everything in that book is received in evidence, everything in that connection.

[fol. 1762] Mr. S. D. L. Jackson: And may we have an exception to the admission of the exhibit in that form?

Judge Allen: Yes."

Counsel for defendants offered in evidence and the Court received as Defendants' Exhibit 154, the Annual Report of TVA for the fiscal year ending June 30, 1937, submitted to Congress December 31, 1937.

Counsel for defendants offered in evidence and the Court received as Defendants' Exhibit 155, a copy of a resolution adopted by the Board of Directors of TVA under date of December 20, 1937 approving a letter attached thereto from John B. Blandford, Jr., General Manager of TVA, to Congressman Woodrum, and as Exhibit 156 a copy of another resolution adopted by the Board of Directors of TVA under date of December 20, 1937.

"Mr. S. D. L. Jackson: May I submit an objection on the ground of their materiality and relevancy, subject to the Court's ruling?

Judge Allen: There is a good deal of evidence in this case that is not material or relevant, on both sides.

Mr. Fly: The letter to Honorable Clifton A. Woodrum is Defendants' Exhibit 155, and the resolution authorizing the acquisition of land and fixing the maximum pool level at Gilbertsville is exhibit 156. Are those received, your Honor?

Judge Allen: They have been received.

Mr. S. D. L. Jackson: Please note our objection and exception."

Counsel for defendants offered in evidence and the Court received as Defendants' Exhibit 157, a certified copy of resolution adopted by the Board of Directors of TVA under date of February 20, 1936.

[fol. 1763] "Mr. S. D. L. Jackson: We object to it as immaterial and irrelevant. And on this matter, I think if the Court please I shall object to the mode of proof.

Mr. Fly: It is a duly certified copy with the seal of the Authority affixed. It is the first time we have had an objection of that character.

Judge Allen: The exhibit is received.

Mr. S. D. L. Jackson: An exception."

Counsel for defendants offered in evidence and the Court received as Defendants' Exhibit 158, a certified copy of a resolution of the Board of Directors of TVA under date of January 25, 1935.

"Mr. S. D. L. Jackson: We object to it on the ground it is immaterial and irrelevant and the mode of proof.

Judge Allen: It may be received.

Mr. S. D. L. Jackson: An exception."

Counsel for defendants then offered in evidence and the Court received over complainants' objections as Defendants' Exhibit 2, a stipulation entered into between the parties.

Thereupon defendants rested.

"Judge Allen: We will proceed with the rebuttal tomorrow. The Court will hear argument, and has asked that proposed findings of fact and conclusions of law be presented immediately upon the close of the hearings.

Mr. Fly: Will there be any lapse of time between the close of the hearing and the argument, your Honor?

Judge Allen: Well, that will depend somewhat upon the natural course of the day and the night.

Mr. R. T. Jackson: We should like to have an opportunity to discuss that with the Court and other counsel if we may, when we are through with the testimony.

Judge Martin: May I personally throw out a suggestion in view of your inquiry? This is just from this one Judge. [fol. 1764] We should like very much to complete the case entirely this week, that is, have all of the proof in, findings of fact submitted, conclusions of law offered and the argument of the case, this week. There are four days left in this present week. Now, that is just the expression of an individual view.

Judge Allen: It is the expression of a second view. But how long do you expect your rebuttal to take?

Mr. R. T. Jackson: I expect we will take three days for our rebuttal, and I had very much hoped that we would not have to work day and night and try to argue the case the next morning to the Court, because I don't believe it would be very helpful to the Court that way.

Judge Allen: Were you asking for a definite period of time?

Mr. Fly: I had hoped and expected that counsel in view of the very small amount of new material that we have brought in in our case, that counsel would finish their rebuttal in two days. Then that would give us Friday and Saturday to finish the argument, and wipe the case out.

Judge Martin: That is what I had hoped, that there would be two days at the outset of more proof, and two days for argument.

Mr. R. T. Jackson: I don't believe we could do that.

Judge Martin: A day and a half for argument.

Mr. R. T. Jackson: Speaking for myself, I am afraid I couldn't do anything Friday, if we finished Thursday.

Judge Allen: The Court is compelled to view the matter, most of all, from the standpoint of its public duty, its obligation under the statute, its obligation to the work of these two District Courts and the Circuit Court. We are compelled to place those matters first, and you will bear in mind that on each side of this controversy there are many experienced lawyers. In other words, this is not a case of one man trying the case on each side. Each side draws upon great resources. It has been the conclusion of the Court, it is the conclusion of the Court, that we shall proceed immediately with the argument, and with the presentation of the findings of fact on the conclusion of the hearing. We are compelled to that.

[fol. 1765] Mr. R. T. Jackson: We should like to have an opportunity to file a motion, and file some objections.

Judge Martin: During the noon recess I have already reset my Court Docket. I keep current by very hard work. I am speaking of my own district now. During the noon recess the District Attorney called me over long distance 'phone with respect to the criminal calendar. The constitution of the United States guarantees a speedy trial. I carry out that constitutional requirement very rigidly.

These men in jail are waiting for trial, awaiting indictment by the Grand Jury. They have a right to be arraigned, tried and sentenced. I have already reset three weeks of my calendar. Of course, we have been out of our districts, respectively, will have been, even at the conclusion of next week, one sixth of a year, a full year, that is two months, and of course, we have those considerations in our minds.

We have, of course, allowed very full cross examination in the case. The rules are very strict, if I construe them correctly, with respect to the limit of rebuttal testimony, so there should not be very much time consumed frankly, in rebuttal, where the case has been fully developed by both sides in chief, and it does seem to me that four days left this week, with four days left this week that the case ought to be in fieri Saturday evening.

Mr. R. T. Jackson: I would like to say this, if I may, of course we are confronted with the situation here where we have one suit, where we might have had 18. It required a great deal of preliminary evidence to go in. We tried to shorten our case as much as we could, at the suggestion of the Court avoiding cumulative evidence, and there has been very extensive and cumulative criticism advanced on the other side of the case. There was much more time devoted to that than we devoted in our case. I think it is a proper case for some rebuttal testimony.

We do not understand the statute, while expediting the great constitutional cases, means that they should be expedited beyond the point where counsel can give every aid that they can to the Court in determining those cases.

Judge Allen: The Court feels that it has allowed counsel to assist the Court at great length.

Mr. R. T. Jackson: My only point is as far as oral argument is concerned, whatever that is worth to the Court or to the litigants, that the opening of that after closing the night before at the end of a very long trial is a substantial denial of right, so far as the litigant is concerned.

[fol. 1766] Judge Allen: If you have any decision of the United States Supreme Court to that effect, I personally should be glad to see it.

Mr. Fly: He has none, your Honor, I am sure.

Mr. R. T. Jackson: I don't claim that I have, when I said I feel that is so as a practical matter.

Judge Martin: I must comment, in view of the statement of counsel, for myself I have never sat in a case as Judge, nor tried one as attorney in which greater latitude was allowed counsel in the full development, both of the charges made by the complainant and of the defenses brought forward to those charges in the way of admission of evidence. We have not even strictly observed all of the rules of evidence. We have allowed latitude on the side of admitting where there was doubt about the competency of it in every case.

So, certainly this Court could not be properly criticised for any expedition unduly, or any haste, or any forcing of counsel to proceed more rapidly than justice would require.

But now when we come to rebuttal, it does not seem to me that counsel should be permitted to cumulate or to produce rebuttal testimony on either side of anything except some very material matter to the administration of justice in this case, and a correct decision of it.

I refer counsel to the authorities with respect to the limit of proof in rebuttal as well established in the United States Court in support of that position.

Judge Allen: Now, in respect to the argument, the Court has decided to allow a substantial time for argument to each litigant, longer than is allowed for the largest case that I have ever seen argued in the United States Circuit Court of Appeals.

But, speaking for myself, after 16 years—this is not for the record.

(Statements made off the record.)

Mr. R. T. Jackson: I did not mean to imply that there had been any undue expedition of the case. I was concerned and am concerned about the question of oral argument, and I thought it my duty to frankly state that to the Court, because it seems to me that is a matter of importance."

[fol. 1766a] **Rebuttal Evidence for the Complainants.**

Counsel for complainants offered in evidence and the Court received, as a part of complainants' case in chief, Complainants' Exhibit 928, being a contract dated March 12, 1934 between TVA and the City of Florence, Alabama;

Complainants' Exhibit 929, being a contract dated March 14, 1934 between TVA and the City of Tuscumbia, Alabama; and Complainants' Exhibit 930, being a contract dated March 14, 1934 between TVA and the City of Sheffield, Alabama.

[fol. 1767] REQUESTS FOR SUBPOENAS DUCES TECUM

"Mr. S. D. L. Jackson: At this time, if the Court please, complainants desire to present to the Court, with the request that the Court permit a writ to issue, certain subpoenas duces tecum against the Tennessee Valley Authority.

The first one is certain described pages out of the detailed statement of budget estimates for the fiscal year ending June 30, 1939, submitted to Congress in December, 1937. This is a description of the pages.

First, 'Navigation, flood control and hydro electric program summary on pages 7 and 8, including justification of estimates, the plan and profile exhibit on page 9, the principal features exhibit on page 10, the channel depth exhibit on page 11, power demand and capacity exhibit on page 14, proposed program of dam construction on page 15, the structures and improvement detail for Gilbertsville Dam and reservoir on page 30, structures and improvement detail for electrical plant and equipment on page 31, and transmission and distribution exhibit on page 32 of TVA detailed statements of budget estimates for the fiscal year ending June 30, 1939, submitted to Congress in December, 1937.'

That is a general description of the statement that was presented. (This subpoena, following a later ruling of the Court at a subsequent session, was identified as Complainants' Exhibit 954.)

I have another one relating to that same document.

Judge Allen: It will not be necessary to read it.

Mr. S. D. L. Jackson: I submit this one in the event the Court does not permit a subpoena to issue for the described pages, because this is a subpoena duces tecum for the entire document, the budget estimates submitted to Congress, and this is only in the alternative. (This subpoena, following a later ruling of the Court at a subsequent session, was identified as Complainants' Exhibit 955.)

The third one is for certain minutes of the Board of Directors of Tennessee Valley Authority approving recommendations or reports relating to methods of operating Norris or Wheeler Dams, or any other dams embraced in the unified plan now under construction, and so forth. (This subpoena, following a later ruling of the Court at a subsequent session, was identified as Complainants' Exhibit 956.)

Judge Allen: The subpoena duces tecum, the application for a subpoena duces tecum with reference to the copy of the report of the United States Department of the Interior, Bureau of Reclamation, is refused. The Court will consider the other requests."

[fol. 1768] Thereupon counsel for complainants, to preserve their objection and exception marked for identification as Complainants' Exhibit 931 the subpoena duces tecum refused in the foregoing ruling.

[fol. 1769] MAJOR R. W. PUTNAM was recalled on behalf of complainants and, having been previously sworn, was examined and testified further as follows:

Direct examination:

I have been on the stand before in the complainants' case in chief and was sworn at that time.

"Q. Major Putnam, the defendants here have presented testimony in this case that it takes no longer for a tow to pass through a high dam lock than through a low dam lock. In the design of a lock what factors govern the size of the valves, and the number and size of the openings into the lock chamber?

Mr. Fly: I object to this as being improper rebuttal. This is a subject which Major testified on expressly in his examination in chief, and it was met in the Government's case. This is just the sort of thing that will spread this case endlessly, if he is to go back and merely pick up the weak spots in his own testimony.

Judge Allen: The memory of the Court is that Major Putnam himself testified upon this point. Objection sustained and you may have your exception.

Mr. S. D. L. Jackson: May we have an exception? And if the Major were permitted to answer he would state that the length and width of the lock chamber, its height, and the rapidity with which water is to be introduced into the chamber are the factors governing the size of the valves and numbers and size of the openings into the lock chambers.

Q. Major Putnam, what is the general practice in the design of locks of different widths and lengths, but of the same height—when it comes to the question of the time of filling or emptying the locks?

Mr. Fly: The same objection.

Mr. S. D. L. Jackson: My recollection is, if the Court please—

Judge Allen: The objection is sustained.

Mr. S. D. L. Jackson: May I state that my recollection is that although Major Putnam testified as to the time of going through the locks, there was no testimony introduced by us in our case in chief as to the design, and the factors and matters of that kind that enter into the construction of locks, [fol. 1770] so as to determine and regulate the times of filling and emptying. That was gone into by the defendants. There are exhibits here showing the times necessary to go through locks of different types, but these matters are preliminary, and leading up to testimony that will directly rebut testimony that the defendants offered here of this nature.

Judge Allen: Major Putnam was on the stand a considerable time. How long was it, Major Putnam?

The Witness: Almost a day.

Judge Allen: We thought so. The Authority, in order to rebut certain testimony of Major Putnam, introduced certain testimony of their own. Now, it is not our understanding of the rule of rebuttal that the case will be reopened on any subject.

Mr. S. D. L. Jackson: We are not asking to reopen the case on the subject.

Judge Allen: Nor that it is proper rebuttal to rebut the direct evidentiary fact leading to the ultimate fact. An ultimate conclusion was reached by Major Putnam and that ultimate conclusion was contested by the Authority.

Mr. S. D. L. Jackson: The point I make is that at the time the Authority contested it, it went into certain computa-

tions and calculations. Now, we have a right to rebut the accuracy of those, even within the limited rule of rebuttal that the Court has stated. And this is what this testimony is directed to, and if permitted to continue it will lead directly to that point in a very short period of time.

Judge Allen: You testified with reference to the time element, didn't you?

The Witness: I testified as to the relative total time required, total time lost in lockages of the two plans. As I recall it, a certain percentage for one, and a certain percentage for another for the entire trip.

Mr. S. D. L. Jackson: We certainly, if the Court please, have the right to rebut these calculations that the defendants introduced here, on times, on lockages and design, and one thing and another of that character. This testimony, if your Honor please, is not merely appended to the testimony that Major Putnam gave in our case in chief. The line of questions which I have, and which if permitted to pursue, I would like to, or I will bring out, shows the inaccuracies and the errors in the computations, and of the opinions given by the defendants' expert or skilled witnesses. Now, certainly the computation that they produce through witnesses in answer to our case in chief is not a matter that we could [fol. 1771] by any possible stretch of the imagination be expected to meet in our case. But if an expert takes the stand, if your Honor please, in defense, and gives an opinion or testimony based on calculations, and he states the basis of his opinion, sets forth his calculations by an exhibit or otherwise, then it seems to me that the Federal rule of rebuttal, or any rule of rebuttal, and even the rule that the Court enunciated from the bench a moment ago, it is perfectly proper rebuttal for the complainants then to show the inaccuracy and the errors and the weaknesses of those opinions and calculations. Now, that is just what we are doing this for.

Judge Allen: The objection is sustained on the ground that the question calls for an answer which is not proper rebuttal. The testimony referred to by counsel for the complainants, pages 3457, 3458 and 3459 of the (stenographic) record, was that of Colonel Watkins on cross examination. The question asked by Mr. Raymond Jackson leading into the subject was, 'How long did you estimate it would take

for lockage through a low dam in comparison with the lockage through a high dam?'

I might say—this is not included in this typewritten ruling, but there is another question on the same page by Mr. Raymond Jackson, 'At what speed do you estimate that a tow with eight barges will make on an average on a round trip.'

The Court has admitted opinion testimony with extreme liberality. Major Putnam, witness for the complainants, gave his own testimony on this subject at considerable length. To recall Major Putnam, an expert for complainants, whose opinion testimony was opposed by defendants' witness Colonel Watkins, an expert for defendants, is to reopen the case on expert testimony, and would lead to an unnecessary and improper examination in rebuttal. This ruling applies to opinion testimony given by experts both on direct, on cross and on redirect examination. This ruling does not exclude evidence in denial of some affirmative case or fact which defendants have attempted to prove. (Carver v. U. S. in 160 U. S. 553, at 555). You may have an exception. You may proceed.

Mr. S. D. L. Jackson: We note an exception to the Court's ruling, and ask leave of the Court that if the witness were permitted to testify he would say that the general practice is to design the valves and culverts to provide for sufficient openings of proper size into the lock chambers, so that the time of filling will be the same. Now, if the Court please, I have several questions bearing upon this same point, which, I take it, are affected by your Honor's ruling, and I think it will save the time of the Court if I may be permitted to ask the questions and make the record. I will try to be as expeditious as possible.

[fol. 1772] Judge Allen: The Court feels that your objection is saved by your exception. You have stated what you want to show and we have ruled against you, and you have your exception, and I will ask you not to ask further questions along this line.

Mr. S. D. L. Jackson: If the Court please, I must respectfully differ with the Court that the question which I did ask and which this testimony will bear upon has been fully or completely stated by the two questions that I have been permitted to ask of this witness.

Judge Allen: Suppose you show the Court the questions.

Mr. S. D. L. Jackson: I will be glad to state it to the Court.

Judge Allen: Suppose you show the Court the question.

Mr. S. D. L. Jackson: I have a form here of the questions and my notes of answers on them. These are questions 3, and I have questions 4, 5, 6 and 7.

Judge Allen: These relate to the same general subject.

Mr. S. D. L. Jackson: Those I am now handing to the Court, that is true, but that is not all the testimony I expect to elicit from Major Putnam. May I have this marked as Complainants' Exhibit 932?

Judge Allen: Major Putnam, didn't you testify rather at length about the time it would take to make these trips, on the lockage?

The Witness: I don't recall that, I spoke in general terms of the percentage of time lost on a trip for lockage, from one end of the river to the other, of 7.3 per cent for the low dam and four per cent for the high dam. I did not, as I recall it, go into the details.

Mr. Fly: You did discuss the breaking of tow at the different sized locks, did you not?

The Witness: I did.

Mr. S. D. L. Jackson: If there is any confusion about the first exhibits——

Judge Allen: What is the fact affirmatively introduced by the defendants that you are rebutting?

Mr. S. D. L. Jackson: That there was no particular difference in lockage time between the small and large locks.

Judge Allen: That is the conclusion, that is the ultimate fact.

[fol. 1773] Mr. S. D. L. Jackson: That is the ultimate fact stated by Major Watkins, and then he said there is time consumed in slowing up, and the Court will recall he said the filling time of the small locks and the large locks is practically the same. Then, I think Mr. Barker——

Judge Allen: All of this was in connection with an estimate asked for by Mr. Jackson?

Mr. S. D. L. Jackson: Well, testing the scope and the background of opinions that the witness expressed. That is the purpose of cross examination, if the Court pleases.

Judge Allen: The Court is not criticizing the cross examination.

Mr. S. D. L. Jackson: I merely point that out, that it is to bring out the hypotheses upon which opinions are expressed, and to lay a groundwork for evidence of the character which we are now seeking to offer.

Judge Allen: Major Putnam, this exhibit is your estimate of comparative lockage time at the locks?

The Witness: It is not my original estimate, it is one based upon testimony given as to thirty-one minutes through a low-lift lock and thirty-nine minutes through a high lift lock, by Mr. Barker, as I recall, and on the assumption that that thirty-one minutes and thirty-nine minutes is correct.

Judge Allen: In other words, this is based on assumption.

The Witness: It is based on assumptions as to testimony given by defendants.

Mr. S. D. L. Jackson: If I may state the testimony of Mr. Barker and the defendants' exhibit to which Major Putnam alluded in answer to the Court's inquiry a moment ago is Defendant's Exhibit 105, and Mr. Barker's testimony, which is testimony in direct appears at pages 4668 and 4669 of the (stenographic) record.

That is not matter which was developed on cross-examination. It was matter which was affirmatively developed by the defendants in the direct examination of Mr. Barker.

Mr. Fly: Of course the main point is that Major Putnam himself testified as to lockage times and he criticized the different sizes of locks, and testified as to the loss of time and inconvenience in breaking tow. He covered this entire [fol. 1774] field. Now, by shading into a matter of detail they want this expert to get on there and furnish additional computations. It is merely a shading on matters of utmost detail. The Major has been over all of this in his main case.

Judge Allen: The Court has made it plain that this ruling does not depend upon the fact that Colonel Watkins' testimony was brought out on cross examination. We wanted to put that testimony in its setting, and that was why we referred to the cross examination. The Court adheres to its ruling. We consider that these proposed questions and the exhibit embody opinion testimony of an expert, who has already testified on the subjects in chief. The opinion

will not be permitted to be asked, and you may have your exception.

Mr. S. D. L. Jackson: Now, may we have an exception? And if the Court please, this is an entirely different matter than has been presented before in this case, namely, the denial by the Court of our right to make a record in the case.

Judge Allen: You have made your record.

Mr. S. D. L. Jackson: But if the Court please, — I don't want to be contentious, — but I cannot make a record unless I am permitted to ask these questions of this witness, and I now earnestly request the permission of the Court to be permitted to make my record so that this question may be presented to the Court on review, by asking the questions of this witness. I will of course abide by the ruling of the Court and will attempt to expedite the matter just as much as possible. But I most respectfully urge we do have a right to make a record in this case. And that ruling of the Court is an entirely different and most serious thing.

Judge Martin: Do you mean by 'making a record' that we have not allowed you to make a record for about eight weeks? Just what do you mean by that, that you have a right on each of these questions, the general line of which we have excluded, on very clear grounds, supported by the Supreme Court authorities cited, do you maintain that you have a right to dictate into the record in response to each question that you offer, the answer which the witness would have given? Is that what you mean by making a record?

Mr. S. D. L. Jackson: And I first have a right to ask each question, and to dictate into the record as an offer to prove, within the meaning of equity rule 46 the substance of these answers.

Judge Martin: In other words, your contention is that you have a right to ask the question and then the objection to the question is sustained, and then you offer to prove what the witness would have answered to that question?

Mr. S. D. L. Jackson: That has been the course followed throughout this trial, if your Honor please. I might say, of course, it is prescribed by Equity Rule 46, and I might add that in the new rules of practice which have been

adopted by the Supreme Court, that is prescribed as the rules which will be followed or the method which will be followed when those new rules go into effect sometime next summer. It is merely an adoption of the rule of *Blease v. Garlington* in 92 U. S. page 1. It does not change the rule. It is existing practice, and I submit we have a right to do that. It is a substantial right of counsel in the case.

Judge Martin: Does the Equity Rule divest the trial court of discretion in the matter of burdening the record with unnecessary details, where the point is clearly preserved for review by the Appellate Court?

Mr. S. D. L. Jackson: But my point, if your Honor please, is that it cannot be clearly preserved for review by the Appellate Court unless I am permitted to ask the question and state in the record in substance, showing so much of what the witness would answer as would clearly show the nature of the testimony that is excluded, as is all set forth in Equity Rule 46.

Judge Martin: Suppose in the instant matter that we are considering, following our ruling that we are excluding the recalling of an expert who has already testified at length in the case to give opinion testimony opposed to the opinion testimony of some witness for the defendants, and we have indicated clearly the basis of that ruling, isn't complainants' right on review to show error in that ruling, if erroneous, clearly preserved by the record as it now stands.

Mr. S. D. L. Jackson: I don't believe so, your Honor. Under the ruling of *Blease v. Garlington*.

Judge Martin: Why is it not preserved?

Mr. S. D. L. Jackson: Now, I might say we have, ready to present, testimony from Major Putnam dealing not only with this narrow point as to the lockage times, but on other matters. And of course the situation cannot be accurately or truly reflected in the record unless this Court permits me to ask these questions, referring back to other specific items of testimony of the defendants' witnesses, which are affirmative facts, a number of which are affirmative facts, and to make my record in each instance.

Judge Allen: Then in this case you could keep us here until April on rebuttal.

[fol. 1776] Mr. S. D. L. Jackson: I can assure you, if your Honor please, that it will probably be the most expeditious way in which the matter can be handled.

Judge Allen: The Court has no assurance of the progress of this case, from the progress of the case.

Mr. S. D. L. Jackson: And I might state that the only way in which the reviewing Court could determine whether or not the evidence offered in rebuttal is proper rebuttal is by having it spread upon the record so that they might consider it.

Mr. Fly: If I might offer an observation, I don't know of any rule of law that requires the statement of each specific question. When a witness is called upon to give a certain line of testimony on a certain subject, then it surely is sufficient that there be a brief outline of his proposed testimony upon that point; and not go through that laborious procedure by taking up each specific question in that field, and then in detail each specific answer.

Mr. S. D. L. Jackson: Well, I think the rule is well defined, and particularly in connection with rebuttal evidence the necessity for it is even more apparent than it might be in the case in chief of either of the parties, because in order for rebuttal evidence to be proper it must be related to certain items of the evidence of the opposing party, and that cannot be shown in any other way in the record unless and until we are permitted to proceed to make up our record.

Judge Martin: The presiding Judge stated this rule does not exclude evidence in denial of some affirmative case or fact which defendants have attempted to prove, but was based on the rebuttal of opinion testimony by the recalling of a witness who has already testified as an opinion witness at great length.

Couldn't you make a statement, Brother Jackson, that would preserve your record, without the use of question and answer form, which would delay us, that would show what you could prove by this witness by way of opinion, if permitted to do so? Couldn't you state that into the record? You have the power of very succinct statement, the Court observes.

Mr. S. D. L. Jackson: I cannot suggest any more succinct method of doing it than to be permitted to state it in response to proper questions.

Judge Allen: The Court at this time is considering the entire scope of rebuttal.

Mr. S. D. L. Jackson: That was as I understood the rule.

ing. Consequently, I cannot do that, in answer to Judge Martin's question.

[fol. 1777] Judge Allen: We bear in mind that an enormous amount of this record is made up of expert testimony.

Judge Gore: Mr. Jackson, do you propose to prove by the questions that you want to ask this witness that the witness Watkins, I believe that was his name, or any of the different witnesses in dealing with the subject now under consideration, took into consideration elements or factors which were not proper to be considered in those things.

Mr. S. D. L. Jackson: Took some into consideration and disregarded others that must be taken into consideration in order for their opinion to be entitled to any weight.

Judge Allen: All of that bearing on opinion testimony.

Mr. S. D. L. Jackson: All of that bearing upon the facts that they stated as to what their opinion was based on. Some of those facts are directly controverted; and it also bears upon the credibility of the witness.

Mr. Fly: If I might observe, I think the clear meaning of the Equity Rule is that in some brief way for the convenience of the Court we get the substance of the proof stated. Certainly under Equity Rule 46 this Court has full discretion as to the matter of detail. I don't think there can be any doubt as to that.

Judge Allen: The Court has special discretion in the matter of rebuttal. The record will show that the complainants offered Major Putnam, an expert for complainants who had already testified in chief, and whose expert conclusions have been opposed by expert witnesses of the defendants, who would, if he had been permitted to testify, have contradicted the factors used by the defendants' experts in their opinion contradictions of Major Putnam's opinion testimony. You may have your exception.

Mr. S. D. L. Jackson: Now, may we have an exception? Major Putnam's testimony, opinion on this particular point, I think would go beyond that, if the Court please. He brings out the inaccuracy of certain facts on which the defendants rely.

Judge Allen: On which opinion testimony is based.

Mr. S. D. L. Jackson: That is right, but that was not stated in the statement that your Honor read, as I understood it. It related to the opinions.

Judge Allen: The ultimate thing is the opinion. Major Putnam gave an opinion based on certain factors. Colonel Watkins and other people gave other opinions based on other factors, brought out both on direct and in cross [fol. 1778] examination. Now, the proposition is we shall go again into these factors for the purpose of getting another opinion, not a denial of an ultimate fact, not a denial for instance of the fact or statement that Norris Dam is 500 feet high instead of 225, or whatever it is; not a denial of the fact that the Tennessee River is some 650 miles from Knoxville to Paducah, or whatever it is; not a denial of a fact. The purpose is a denial of an opinion.

The Court has made that plain, and the Court's ruling stands.

Mr. S. D. L. Jackson: Might I have an exception? And again, even at the risk of appearing to be contentious, I would like to state that I think also that Major Putnam's testimony, and this testimony which is offered, does deny certain facts which were introduced in evidence by the defendants here. And may the record show—

Judge Allen: Major Putnam stated to me that the exhibit was an opinion based on certain assumptions. That was the effect of his statement. I thought him better qualified to testify than anyone else on that subject.

What are the facts now which you claim are going to be shown by this evidence?

Judge Martin: The rebutting fact, not the rebutting opinion, but the rebutting fact.

Mr. S. D. L. Jackson: That in the construction of locks that the construction is different in locks where the lift is to be of a different degree, so that in the actual construction the valves, culverts and openings into the chamber are given such dimensions and spacing as to let the water in as fast as possible without creating disadvantageous surges. Where the surge is too great—well, I take it perhaps that part is an opinion. But I take the first part to be a definite fact.

Judge Allen: Bearing upon an opinion.

Mr. Fly: Lockage time, which in turn goes to another ultimate fact of the advantages of high dams over low dams. It is one of those shadings of this detailed evidence. It is not an ultimate fact in any sense of the word.

Judge Allen: The Court will permit counsel to ask ques-

tions calling for denials of affirmative cases or facts which the defendants have attempted to prove.

Mr. S. D. L. Jackson: May I in connection with the statements which have been made as to this particular phase of the testimony, let the record show the offer of complainants' exhibit 932 in connection with this. That is the one [fol. 1779] that relates to this matter we have been discussing. I wanted to show that was offered as part of or in connection with the offer to prove the testimony in this particular phase of the case. I take it the ruling is that it is excluded.

Judge Allen: Let the record show it is excluded, and you may have your exception. Let the record show that this is the exhibit concerning which the Court interrogated Major Putnam, and he said that it was an estimate based on certain assumptions, and on certain figures in the record. Is that correct, Major Putnam?"

(Complainants' Exhibit 932 referred to in the foregoing ruling of the Court was later received in evidence by the Court. See side folio 1807 of this record.)

"The Witness: That is correct.

Mr. S. D. L. Jackson: May we have an exception to the exhibit being excluded. If the record does not so show, may the record show that that exhibit was prepared by him or under his direction?

Judge Allen: Yes.

Mr. S. D. L. Jackson: If I have not already done so, may I reserve an exception to the Court's ruling as to the refusing to permit me to ask these questions and state the answers as the offers to prove.

Judge Allen: The ruling was made upon the ground that it appears from the examination of the questions and the examination of Major Putnam that the ultimate facts to be contradicted by the exhibit and by the facts mentioned in the questions is an opinion. In other words, what is sought here is the contradiction of an opinion and not the contradiction of a fact affirmatively attempted to be proved by the defendants.

Mr. S. D. L. Jackson: May we have an exception? We will attempt to prepare a short statement and submit it to the Court at some future time on the point."

As to the testimony of the defendants that terminal operations under the low dam plan would be subjected to material additional expense on account of rapid and frequent fluctuations of the river, in the low dam plan for navigation, in the case of terminals, where there are cranes and derricks and the operations are by direct lifting, no adjustments would have to be made where the changes in stages are as great as four feet a day, as those terminals are built in such a way that it is merely a question of how [fol. 1780] far a bucket or tongs would be dropped in order to pick something up. Some terminals are equipped with chutes, belt conveyors and escalators, the type of equipment which runs on an incline, and freight is either slid down or pulled up by means of belts or otherwise, hinged at the inner end and raised and lowered at the outer end. In the normal daily operations at such terminals, they have to encounter the difference in elevation of whatever is the difference between the height of a barge when loaded and the height of a barge when unloaded, and that normally exceeds four feet, so that a daily fluctuation of as great as four feet would not be something that they do not encounter every day anyway.

"Q. About how many days during the year on the average do you estimate that fluctuations in stage in excess of two feet a day would occur at the following places: Florence, Alabama, Johnsonville, Tennessee and Chattanooga, Tennessee?

Mr. Fly: May it please the Court, reviewing the summary of Major Putnam's testimony, I find that he testified on this subject, the fluctuations of pool levels, the effects on terminals, both on his direct and on his cross examination during complainants' case.

Mr. S. D. L. Jackson: I don't believe so.

Mr. Fly: He gives the difference in terminal costs, port by port, and shows \$281,249 cheaper largely because of greater fluctuation.

Judge Allen: What page?

Mr. Fly: I will have to look up the page. I have a summary of the testimony.

At another point, he referred to the fluctuations in the pool at Norris, and indicated great difficulty with terminals at Norris Reservoir because of the fluctuations.

Mr. S. D. L. Jackson: I recall testimony, something about the fluctuations at Norris.

Mr. Fly: This question is just shading into the utmost detail on subjects that this witness covered at the outset. And if he did not cover it in detail at the outset, it means no more than it means as a matter of utmost detail.

[fol. 1780a] Judge Allen: The question plainly calls for an estimate.

Mr. S. D. L. Jackson: Oh, this question plainly calls for an estimate, there is no question about that.

Judge Allen: Yes. This is not the stage of the case to be introducing opinion testimony, Mr. Jackson, you know that. The proper and usual form of a question in rebuttal is 'Is it or is it not a fact that so and so'.

Mr. S. D. L. Jackson: I must differ with the Court. I don't think there is any particular form of question that is applicable to rebuttal testimony.

Judge Allen: The objection is sustained to the question.

Mr. S. D. L. Jackson: May we have an exception?

Judge Allen: You may have an exception.

Mr. S. D. L. Jackson: And if the witness were permitted to answer he would state that based upon an examination [fol. 1781] of the daily hydrographs—

Judge Allen (interrupting): He would give an opinion.

Mr. S. D. L. Jackson: Yes, that the daily fluctuations in excess of two feet at Florence will occur on the average of about sixteen days per year, at Johnsonville, about 27.7 days per year, at Chattanooga, 31.2 days per year. That is the opinion that he would give in response to that question if he were permitted to answer.

Judge Allen: Does the Authority make a motion to strike the answer from the record.

Mr. Fly: Yes, I will make such a motion.

Judge Allen: The offer is stricken. It comes within the plain ruling of the Court. It comes within the law. The Court has shown the utmost latitude to the complainants in every branch of this case. It has shown latitude also to the defendants. —We have come to a time when this case should be run according to the rules of evidence, and those rules have been read from the decision of the Supreme Court.

Mr. S. D. L. Jackson: Well, I don't understand, if the Court please, that—

Judge Allen: The question calls for an opinion. Major Putnam has given his opinions. His opinions have been controverted. It is not proper rebuttal to let him again give opinions on these matters.

Mr. S. D. L. Jackson: If the Court please, he gave no opinions on this matter, on our case in chief. This matter was injected into this case by the defendants, these wide fluctuations on these pools. We had no opportunity, absolutely, on our case in chief to go into this matter because that was injected when the defendants got to their answer.

Mr. Fly: Why didn't you have the opportunity in your case in chief, if fluctuations meant anything?

Mr. S. D. L. Jackson: They didn't, until you began saying they did.

Judge Allen: Opinion evidence in any case is not a fact. It is a matter of judgment.

Mr. S. D. L. Jackson: Well, I am sorry, but if I understand, this was the Court's ruling. It is that when the defendants in their case go into certain phases and give opinion evidence on it, then there is no right ever to the plaintiffs to controvert those opinions.

Mr. Fly: The Government pointed out that this witness testified on the subject of fluctuations of pool levels, in regard to terminals, both as to tributary dams and as to main stream dams. It went into the item of cost of, I think, [fol. 1782] \$281,000, I don't know for what period, due to fluctuations, in his own words. If he is coming back now on some further details of fluctuation, you have no right to make any such broad statement.

Mr. S. D. L. Jackson: I was not stating your position.

Judge Allen: The ruling stands, and you may have your exception.

Mr. S. D. L. Jackson: I was stating my interpretation of the Court's ruling.

Judge Allen: You may have your exception, and let us proceed with the case.

Mr. S. D. L. Jackson: Now, on this point, if the Court please, may we have now the right to present for the record a statement of the balance of the questions, which we have on this point? There will be three of them.

Judge Allen: May the Court see them?

Judge Allen: The record may show that Major Putnam if permitted to answer would have made certain statements concerning fluctuations in stages on the Tennessee River,

and concerning the results of some studies as to the extreme fluctuations produced by flood stages on that river, and you may have your exception.

Mr. S. D. L. Jackson: If the Court please, may I respectfully except to the statement of the Court, if it is to be understood as being a statement of the substance of the testimony, within the meaning of the Equity Rule 46.

Judge Allen: The ruling is all inclusive; it states the subject.

Mr. S. D. L. Jackson: Will the Court permit me to have this sheet marked as an exhibit and shown in the record.

Judge Allen: That application is overruled, and you may have your exception to that.

Mr. S. D. L. Jackson: May I have an exception.

Judge Allen: The Court considers that this entire line of offering of testimony is a reopening of the case.

Mr. S. D. L. Jackson: I might state, the questions were submitted to the Court at its request, and were examined by the Court. There is no way in which a reviewing Court can consider the questions unless we are permitted to make them a part of the record.

Judge Martin: Brother Jackson, hasn't the Court by now made it pretty plain to you, sir, that the position taken [fol. 1783] is that you do not have the right, since we have clearly indicated the basis of exclusion, to dictate in question and answer form or the like, what you expect to prove by this recalled expert witness on rebuttal on an opinion expressed by a witness for the defendants? Now, that is very clear to you, and we don't want to encumber this record with what we deem to be useless material of no help to the reviewing court. That is the basis for refusing to permit that exhibit to go into the record.

Mr. S. D. L. Jackson: I understand the Court's position, if your Honor please, and I am trying within the Court's ruling merely to make a record as we feel that we should be permitted to make, as counsel, in order to present clearly to the reviewing Court the nature of this material which was submitted to this Court, and what we will expect to prove by it. I will be very glad to shorten it all I possibly can, and present it in the most succinct form possible. But the right to make a record is a substantial right of counsel in the case.

Judge Martin: Which we think has been carefully preserved by the Court.

Q. Major Putnam, the defendants have testified to the effect that wind action on tows—

Mr. S. D. L. Jackson: This, I might say, is a different subject. I don't believe there is any testimony in complainants' case in chief bearing on the wind action on tows.

Judge Allen: There is testimony bearing on the action of wind and waves.

Mr. S. D. L. Jackson: Waves.

Judge Allen: Didn't you testify about wind?

The Witness: I don't recall except as it produced waves, your Honor. I may be mistaken.

Mr. Fly: Do you recall defining fetch?

The Witness: I recall defining fetch, yes, I do.

Mr. Fly: And the amount of open water?

The Witness: The unobstructed distance over which the wind blows.

Mr. Fly: The unobstructed distance. I think you referred to the effect of river banks and that sort of thing on wind action also.

The Witness: Referring only to waves, Mr. Fly.

Mr. Fly: In the (stenographic) record at pages 1961 and 1962 on cross examination, it is gone into at great length. This witness brought in wind and wave action, and there [fol. 1784] is no wave action without a wind, I assume on those lakes. He is just trying to go back and patch up some matter in the most intimate sort of detail here.

Mr. Fitts: They put on another witness who testified to nothing else.

Mr. Fly: Oh yes, that is true. On the main case, Colonel Willson testified to nothing else except wind and wave action. It matters not if this witness did not cover it fully, now is no time to go into detail on that sort of thing.

Mr. S. D. L. Jackson: I don't agree with counsel's statement of the testimony offered on our case in chief. My recollection is that Colonel Willson testified as to the effect upon his fleet of barges of going on Wilson Lake and Wheeler Lake. Now, I think the shortest way is to permit me to read this first question on this particular group of testimony.

Q. Defendants have testified, Major, to the effect that wind action on tows navigating the upper reaches of the pools on the low dam system will create substantial delays and hazards, and that these delays and hazards will offset adverse conditions resulting from wave action on the TVA

lakes. What is the common practice in handling a tow when it is subjected to winds, which tend to throw it off its course? That is a question of fact, as I understand it.

Mr. Fly: Even so, it is the same subject that was gone into as a matter of fact in the case in chief by two witnesses.

Judge Allen: The objection is sustained. The question calls for an answer which is not proper rebuttal. You may have your exception.

Mr. S. D. L. Jackson: May we have our exception and may we be permitted to present to the Court a statement as to what we would expect to prove by this answer?

Judge Allen: Present it here, Mr. Jackson.

(Document handed to Court.)

Mr. S. D. L. Jackson: Those two at the bottom of the first question there (indicating). If the witness were permitted to answer he would state that the rudder would be set over so as to tend to turn the tow to the wind; the rudder power thus offsetting the wind effect. Now, may I ask this—

Judge Allen: What other question on there calls for anything except judgment?

[fol. 1785] Mr. S. D. L. Jackson: I don't suppose any of them on that sheet. But, may I ask one question just to preserve the record?

Q. Major Putnam, are there any difficulties or disadvantages involved in this operation?

Mr. Fly: Objection.

Judge Allen: The objection is sustained.

Mr. S. D. L. Jackson: May we have an exception and may I be permitted to state briefly—

Judge Allen: You will be permitted to state the general conclusion.

Mr. S. D. L. Jackson (Continuing): That there are no difficulties, the only disadvantage is extra power required to propel the tow.

Q. Major Putnam, what winds are most effective in throwing a tow from its course?

Mr. Fly: Objection.

Judge Allen: Objection sustained.

Mr. S. D. L. Jackson: May I have an exception? If the witness were permitted to answer he would state 'Cross winds'.

Q. Under what conditions are cross winds to be guarded against?

Mr. Fly: We object to that.

Judge Allen: Objection sustained.

Mr. S. D. L. Jackson: May we have our exception?

Judge Allen: Can't you now cover the rest of these by some general statement?

Mr. S. D. L. Jackson: I will try, your Honor. If the witness were permitted to answer this question and other questions relating to this same general subject, he would testify that cross winds are to be guarded against when there is a wide open sweep, and also where the channel is narrow; that under the comparative conditions as to wide open sweeps and narrow channels, as between the TVA plan and the low dam plan, under the TVA plan there will be about 138 miles where there is a wide open sweep and cross winds; that there will be less than 47 miles of channel within the banks of the river; that under the low dam plan— There would be little channel exposed to a wide open sweep, and there will be nearly 184 miles of channel within the banks of the [fol. 1786] river, of which about 130 miles will have a width of 400 feet or more."

As to the testimony of the defendants to the effect that the high dam channel is very narrow as compared with the total overflow area, waves begin to be affected by depth of water when the depth of water is three times or more than the height of the waves. Waves three feet high would be undisturbed when the water was about nine feet deep. The Gilbertsville pool at mile 30 from Paducah for nine foot depth at elevation 370 is about two miles in width. The longest fetch at mile 30 for the same elevation of 370 is between twelve and fourteen miles. At mile 40 the width of the Gilbertsville pool for a depth of nine feet of water at pool elevation 370 is about 2 to 2½ miles. The longest fetch at mile 40 for this same 9 foot depth is nearly 15 miles. The width of Gilbertsville pool for a depth of 9 feet at pool elevation 370 is about 1½ miles at mile 50 and the longest fetch at mile 50 for this 9 foot depth would be nearly 15 miles.

"**Q.** Now defendants have testified that it will not be necessary to load river equipment somewhat lighter or to

increase its structural strength to meet conditions imposed by waves and wave action. That, if the Court please, is in connection with Colonel Watkins' testimony at pages 3507 and 3508 of the (stenographic) record. In the commercial operation of vessels on inland waterways what usual important steps does an owner have to take before he is allowed to operate, and before he may obtain insurance on his vessel and cargo?

Mr. Fly: I object to that. On the main case this witness testified specifically on the types of equipment which were in use on the Ohio and Mississippi, and he even stated his conclusion that certain equipment would not come onto this river. I can look up additional references too, but it is simply a rehash of the old subject.

Judge Allen: The objection is sustained upon the ground that the inquiry leads us into something very remote and immaterial, under the issues of the case.

Mr. S. D. L. Jackson: May I have an exception? The question however asked was, in the commercial operation of vessels on inland waterways what were the steps an owner has to take. That might have been obscure. An exception and offer to prove: That the plans of the vessel are submitted to the American Bureau of Shipping for approval as to strength, and stability. Marine surveyors check the [fol. 1786a] routes proposed to be operated on, and when the vessel is built, trial tests are made by surveyors, and when the tests are completed, a certificate is issued by the [fol. 1787] Department of Commerce prescribing limitations as to draft, freeboard, and otherwise. Only then may insurance be obtained upon the limitations thus fixed.

Q. What differences, if any, exist in the general design of inland waterway craft, those that are to be operated on waters subject to substantial wave action?

Mr. Fly: Objection, both on the ground that this entails matters of wind and wave action, which this witness dealt with most of all, more than all of the other witnesses put together, and this witness, as a part of complainants' case, also dealt with the matter of freeboard, of the type of equipment that would come on the river, and all that sort of thing. I don't think we ought to have to go back over this

case and go over the whole matter in detail from the beginning.

Mr. S. D. L. Jackson: This testimony, I believe, also relates to the testimony of the witness Brodie.

Mr. Fly: Of course, it does. Mr. Brodie was answering Major Putnam's testimony.

Judge Allen: The objection is sustained.

Mr. S. D. L. Jackson: May I have an exception? If the witness were permitted to answer he would state that river craft are generally designed to keep water out of cargo with only sufficient framing to provide strength to stand strains incident to loading, unloading, docking and undocking, and where wave action is involved which imposes irregular stresses, it requires strengthening of the frame, thus increasing the weight of the vessel by a large percentage."

As to the testimony of the defendants that the equipment of the Federal Barge Line will be adaptable to use on the waterway resulting from the execution of the TVA project, I am familiar with the equipment of the Federal Barge Line, as my company handled their towing operations on the Chicago River for one whole season. The equipment of the Federal Barge Line in use on the Mississippi and its tributaries is distinguished for being much more substantial, heavier and more expensive than equipment of equal size generally used by other operators on these waterways. For a cargo barge of about 2,000 tons, the [fol. 1783] difference in costs amounts to as much as \$15,000.

The effect of the use of the shelter spots which are being made along the shores of Wheeler Lake for river equipment to put into in case of storms will affect the navigating time, increasing it by as much time as it takes to go into, to stay in, and to come out of, these shelters.

As to the testimony of the defendants that most of the traffic on Norris Lake would be a downstream movement of coal, most of the coal mining operations near Norris Lake are near the head of the Powell River branch of the reservoir. The length of the Powell River branch, having a nine foot depth at maximum pool elevation, is about 61 miles. When Norris pool is at elevation 1020, that length of a nine foot depth on the Powell River branch is 53 miles and when Norris pool is at elevation 955, that length is about 38 miles. If coal is to be loaded at the head of Powell

River branch of Norris Lake, it would be possible to locate a terminal about 25 miles from the mines at a point where a nine foot channel would be available all of the time. Such a terminal would be a very high structure, requiring an expensive conveyor installation, so arranged that the outer end would have to be raised or lowered almost 100 feet. As an alternative, a terminal could be built there on a float or rails, paralleling the channel to avoid this excessive lift, but it would have to be moved back and forth along with shore equipment, as the reservoir rose or dropped during the season.

A barge lift, if one were to be constructed at Norris Dam, as testified to by the defendants, would have to be built over the spillway of the dam or over the power house or over the bank on the left hand side of the stream looking down stream. If built over the power house or spillway, it would have to be substantially longer than if provision had been made for it before. If built over the hill on the left bank, [fol. 1789] it would be considerably longer, resulting in any case in a substantially greater expense.

The sketch (offered and received in evidence as Complainants' Exhibit 933) is entitled "Coal transfer and transit facilities, Norris project". This sketch is the same as Defendants' Exhibit 103, except that it contains some figures and notations which were added by me and which show the actual elevation of the upper section of Norris Dam based upon the scale shown on the original exhibit of defendants. The figures at the bottom of 960 and, going to the top, of 1040 and the two lines extending to the right marked "Elevation 1034, top of gates, and elevation 1028, bottom of tunnel" and the words at the bottom "Elevations shown above added by complainants" are the additions that I have made to Defendants' Exhibit 103.

"Q. Major, defendants have testified that low water releases of water from Norris and Hiwassee reservoirs would so increase depths of the Tennessee River before completion of the main river dam as to have an important effect towards increasing commerce in the lower part of the river. To what extent, if at all, would enrichment of the low water flow of the Tennessee River during the construction and before the completion of the TVA Unified Plan benefit navigation?

Mr. S. D. L. Jackson: That is, I believe, a new point that—

Mr. Fly: This witness testified on the main case as to the effect of the releases from Norris on navigation. There is a further objection to this question in that it has got two or three questions wrapped up in one, as to navigability of the river, and the amount of commerce and all of that. It ought to be broken down, but I don't think any of it is pertinent, after this witness has once testified upon the effect of those releases on the downstream depth.

Judge Allen: If you answered this question, what would you be giving, Major Putnam?

The Witness: I would be giving the effect on the navigation on the Tennessee River as pertains to its cost of operation.

[fol. 1790] Judge Allen: You would be giving your opinion?

The Witness: Giving my opinion in the interim period.

Mr. S. D. L. Jackson: I should have stated that. I think this properly does call for an opinion.

Mr. Fly: We didn't go into that subject.

Judge Allen: Objection sustained upon the ground it calls for an opinion.

Mr. S. D. L. Jackson: May we have an exception and state if the witness would be permitted to answer, he would state the navigation would be benefited by temporary increased depths in certain portions of the Tennessee River during the construction period of the TVA Unified Plan. I would like to ask one more question along this same line. I apprehend the objection will be sustained.

Q. What would be the value of this temporary benefit to navigation on the Tennessee River pending execution of the TVA Unified Plan?

Mr. Fly: Objection.

Judge Allen: This is your estimate and opinion?

The Witness: Yes.

Judge Allen: An objection would be sustained if made.

Mr. Fly: I did make it, your Honor.

Judge Allen: All right, the objection is sustained.

Mr. S. D. L. Jackson: Exception. If the witness were permitted to answer, he would testify that this interim benefit would be about \$30,000 a year.

Q. Major, it has been testified by defendants that the release of stored water from Norris and Hiwassee reservoirs will be of benefit to navigation on the Tennessee after completion of the TVA project by way of increasing the depths at the upper end of the pools. It has also been testified that this regulated flow would increase the current velocities at the heads of the pools to about $2\frac{1}{2}$ miles per hour. What is your opinion with reference to these two effects?

Judge Allen: Is there objection?

Mr. Fly: There is an objection. If I understand the question, it is just a springboard for a speech, and I don't know what the speech is going to be.

Judge Allen: The objection is sustained.

Mr. S. D. L. Jackson: May I have an exception? If the witness were permitted to answer he would state [fol. 1791] the benefits of increased depths would be off-set by the disadvantages of increased current velocities.

Judge Gore: Read that question, Mr. Jackson. I think I asked that question myself of the defendants' witness. I was interested in it.

Mr. S. D. L. Jackson: If permitted to answer, the witness would state that the benefits of increased depth would be off-set by the disadvantages of increased current velocities.

Judge Gore: All right.

Mr. Fly: I think, your Honor, I will concede that the witness has so testified. I didn't understand the question as I stated. I thought it went to the question of whether or not the releases from Norris would have a general permanent value in aid of navigation. This witness has already testified on that subject. This is a slightly different point, that is as to building up navigable depths at the upper reaches of the reservoirs.

Judge Allen: The Court has sustained the objection not upon the ground that you mentioned, Mr. Fly, but upon the ground that it calls for an opinion, and it does call for an opinion, even though it is on a slightly different point.

Q. Testimony has been introduced by the defendants, Major, to the effect that the release of stored water from Norris and Hiwassee reservoirs will materially increase the navigable depths in the Ohio and Mississippi Rivers, so as to be of substantial benefit to navigation. Will you

state what the facts in this matter are? Now, in that connection, that relates to a computation of records, and in that connection I would like to state it is our position that whether or not navigation on the Mississippi River might be benefited is of no moment in this case, because there is no obligation imposed upon these defendants under the statute or any place else to aid navigation on the Mississippi River. Testimony was introduced by the defendants bearing upon that point, and that is the reason for our desiring to go into this line of rebuttal testimony.

Mr. Fly: This witness has testified specifically on that point.

Mr. S. D. L. Jackson: That still is his opinion. I will be glad to ask the question.

Judge Allen: The objection is sustained for the same reason.

Mr. S. D. L. Jackson: May I have an exception. If the witness were permitted to answer he would state in his [fol. 1792] opinion it still would have none."

As to the testimony of the defendants that the Army Engineers are not building any more low movable dams, I know of one project now under construction by the Corps of Engineers using low, movable dams. This project is on the upper Mississippi River between St. Louis and St. Paul.

Cross-examination:

The Mississippi River goes through St. Paul. I did not say anything about a dam—I said a project. The project is near St. Paul and right there there is a high lift dam, if that is what you are looking for. It is one out of 26 dams in the project.

Direct examination continued:

The Corps of Engineers began building locks and dams of intermediate lift on the upper Ohio River about the year 1926. The total traffic which was being moved on the Ohio River at that time was about 20,000,000 tons a year. I know of a current official proposal for the use of wicket dams on an important inland waterway.

"Q. Please state briefly what that proposal is.

Mr. Fly: I object to the hearsay as to what the proposal is.

Judge Allen: The objection is sustained to what the proposal is. The Major may state the site. What is the site of the project?

The Witness: The site of the project is at the site of five dams on the Ohio River.

Mr. S. D. L. Jackson: May the witness be permitted to state the reference to the official document?

Judge Allen: May the Court see the document?

Mr. S. D. L. Jackson: I direct the Court's attention to page 157 of this document, the one little paragraph, with the line drawn around it, and state that if the witness were permitted to answer,—well, wait a minute."

[fol. 1792a] (The document referred to was House Document 306, 74th Congress, First Session. It was subsequently offered in evidence as Complainants' Exhibit 936 and was excluded by the Court upon objection of counsel for defendants.)

[fol. 1793] Examination by the Court:

As to whether it is an official Governmental project, the project proposed is not authorized by Congress; if that would answer your question. It is proposed only by an officer of the Corps of Engineers and his superiors.

"Mr. Fly: I think in any case that would be objectionable. I would assume that the Chief of Engineers had made a formal recommendation to the Congress. If it is simply a recommendation of certain officers of the Corps, I think it is clearly objectionable."

Direct examination continued:

"Q. In connection with the former question, the former matter, Major Putnam, will you state please with reference to this wicket dam project that you have mentioned whether or not the proposal was to increase the height of the wickets?

Mr. Fly: I object to that.

Mr. S. D. L. Jackson: Merely that one fact is all I want to bring out.

Mr. Fly: I don't care how many facts. Here is a proposal of the Chief of Engineers which has been rejected. It has not been carried up by the Chief of Engineers, it has not been adopted by Congress, and what difference does it make that a district engineer at some time past thought one of those dams a good idea.

Mr. S. D. L. Jackson: It has not been rejected, if the Court please. It was approved by the division engineers and by the Board of Engineers.

Judge Allen: The objection is sustained.

Mr. S. D. L. Jackson: May I have an exception? And if the witness were permitted to answer he would state that the proposal was to increase the height of the wickets by two feet.

Q. Major Putnam, it was testified by defendants that the low dam plan would slightly increase floods on the lower part of the Tennessee or Ohio and Mississippi; also that the low dams on the main stream would prevent the use of dams for flood control. What effect, if any, would a properly designed low dam project have on floods on the Tennessee, Ohio and Mississippi Rivers?

I realize I am asking for the witness' opinion.

Mr. Fly: I thought he covered this subject on the main case.

[fol. 1794] Mr. S. D. L. Jackson: I don't think so.

Mr. Fly: I object to it.

Judge Allen: The objection is sustained.

Mr. S. D. L. Jackson: May I have an exception? And if the witness were permitted to answer, he would testify that such a project would have no effect, if properly designed. One follow up question. Would the construction of low dams in any way affect the possibility of the subsequent erection of the high dam?

Judge Allen: Just a minute, please.

Mr. Fly: I object.

Judge Allen: The objection is sustained. You may have your exception.

Mr. S. D. L. Jackson: May we have an exception? If the witness were permitted to answer, he would state that they would not, unless they were located exactly on the sites proposed for the high dams."

Assuming that all of the structures in the TVA Plan were built except Gilbertsville, and operated as testified by

the defendants as to low water regulation, the subsequent erection of Gilbertsville would not result in any substantial benefit, for the defendants have testified that during 70% of the time there would be a nine foot channel in the Tennessee River between Paducah and Pickwick, and that due to the regulation of low-water flow from tributary reservoirs, there would be a 7 to 7½ foot channel 100% of the time. The deficiency in depth could be made up comparatively easily by a moderate amount of dredging, and the value of Gilbertsville, as now proposed, at an elevation of 375 feet, with what I believe to be its disadvantages to navigation, would have to be measured against the cost of obtaining a nine foot channel by dredging.

The table appearing on page 925 of Defendants' Exhibit 153 shows that the navigable channel depth on the Tennessee River below Pickwick Landing pool down to Paducah will be 8½ ft after all other structures (including Hiwassee but not including Gilbertsville) are completed. There again, but to a different degree, the deficiency can be fairly [fol. 1795] easily made up by dredging, so that balancing the benefits against the detriments, it is my opinion that Gilbertsville would have no net benefit to navigation.

"Q. If you were called on to operate the TVA system of dams on the Tennessee River for the primary purpose of navigation, what would be your general rules, if any, as to the maintenance of reservoir levels? This, I realize, calls for an opinion, but again a change in type of construction has now been shown to have taken place here during the course of this trial.

Mr. Fly: You mean to say the witness didn't know the type of construction? He inspected every one of the dams. He said he was familiar with the plans, had made full study of them, and qualified himself extensively. And it is quite inappropriate to go into all of this, and I object to it.

Mr. S. D. L. Jackson: As to the dams which had not been constructed, of course there are material changes that now appear to have been made, and particularly there is testimony as to the proposed method of operation.

Judge Allen: The Court permitted the other question upon the sole basis of the existence of this report. This question falls within the previous ruling, and we sustain the objection.

Mr. S. D. L. Jackson: May I have an exception?

Judge Allen: Yes.

Mr. S. D. L. Jackson: If the witness were permitted to answer, he would state that he would keep the main river reservoirs at not less than flat pool level and that as low an elevation above that as long as possible; that during floods the storage space above flat pool would be utilized as far as possible in controlling floods.

Q. If you were called upon to operate the TVA system of tributary reservoirs for the primary purpose of navigation on the main river, what would be your general rules as to the control of discharge and as to the maintenance of reservoir levels?

Mr. Fly: I object to that as again without any hypothetical basis.

Judge Allen: The objection is sustained.

Mr. S. D. L. Jackson: May we have an exception? And if the witness were permitted to answer, he would state that the only rule he would have so far as navigation was concerned, would be not to dump the storage in such a way as to increase the height of the major flood in the main stream. [fol. 1796] Judge Allen: The Court desires to finish with this case on Saturday, that is, finish with the presentation of the case, and to have the case in its hands at the conclusion of the session on Saturday. That is our objective.

Mr. S. D. L. Jackson: All I can assure the Court is that we will proceed as speedily as we possibly can."

I am able to identify the source of the data shown on Defendants' Exhibit 30, which purports to show, among other things, gross water-borne commerce on inland waterways of the United States, 1919 to 1934. The source of this data is from the annual reports of the Chief of Engineers, United States Army, appearing year by year in Part IV of the book. By actually taking the readings off of the top graph and comparing them with the statistics shown in that report as to grand total traffic, rivers, canals and connecting channels, I find that they correspond as closely to the graph as it may be read. I also find the same thing to be true with an examination of the graph showing the traffic on the Mississippi River and its tributaries. I find the statistics are correctly plotted, if we assume that the title "Total Traffic, inland waterways", appearing on Defend-

ants' Exhibit 30 corresponds to the title "Grand total, rivers, canals and connecting channels," appearing in the annual reports of the Chief of Engineers. The figures which are represented graphically on Defendants' Exhibit 30 do not make any allowance for duplications that might exist.

The annual reports of the Chief of Engineers do contain statistics for the traffic on canals, channels and rivers, eliminating duplications, and these statistics are different from those under corresponding headings, as plotted on Defendants' Exhibit No. 30.

"Q. Using the figures on Defendants' Exhibit 30, what rate of growth of traffic is shown for the period, 1932 to 1934, inclusive?

Mr. Fly: I object. The exhibit speaks for itself. [fol. 1797] Mr. S. D. L. Jackson: This is merely preliminary. I expect to show that in contrast to what the other figures show.

Judge Allen: He may answer.

Mr. Fly: I want to object to it on that ground, your Honor. Now, he is not only giving his opinion as to there being a difference, but he is going to give oral testimony as to the details of the difference. I don't think we ought to be subjected to that sort of prejudicial and erroneous testimony.

Mr. S. D. L. Jackson: I might state the defendants had the first shot at this exhibit, in getting it in here. Its inaccuracies are no fault of ours.

Mr. Fly: Yes, but you can produce the document. You are testifying as to the content of the document, and the document will speak for itself. You have been to law school.

Mr. S. D. L. Jackson: Yes. Of course, if I might interject—

Judge Allen: The objection is sustained and the Court will ask you to bring in the report on which you base that question.

Mr. S. D. L. Jackson: May I ask the witness one question? They may all be in the Court room, I don't know, I didn't personally make a check.

Judge Allen: The Court will also ask you to point out the place where it is from.

Mr. S. D. L. Jackson: If given a few moments time we will be very glad to do that.

Q. Are those all in the annual reports of the Chief of Engineers?

A. They are all in the reports of the Chief of Engineers for the year subsequent to the traffic year reported on.

Judge Allen: Mr. Jackson, the Court requested you in the colloquy that we had here between ourselves not to make your offers of proof in question and answer form because it consumes so much time. We are quite aware of the situation confronting you. Although we did notify counsel several days ago in advance of the fact that rebuttal proof would be confined to rebuttal, notice was given of that fact, our precise ruling upon this question of opinion testimony was not in your hands until today. For that reason, we have been patient with the situation, we have understood it, and we have also thought that we got along faster today to go along as we have. Tomorrow we shall expect that the offers to prove will be given in succinct statements instead of in [fol. 1798] question and answer form. That will help both of us.

Mr. S. D. L. Jackson: Very well.

Judge Allen: I mean all of us; and furthermore the Court again repeats that it expects this case to be concluded, the argument over, and the requests for findings of facts in our hands on Saturday."

(Counsel for complainants then offered as a part of their case in chief a table, which was received in evidence as Complainants' Exhibit 934, giving the detailed figures for the gross hydro generation of the Alabama Power Company testified to by the witness Barry who had in his testimony given the total figures. The witness Barry had prepared this table, Complainants' Exhibit 934, and the defendants stipulated that if Mr. Barry were recalled to the stand and asked appropriate questions, he would identify this table as the breakdown of the total figures to which he had testified.)

The figures containing the grand totals of river, canal, and connecting channel traffic for certain years are shown in the annual reports of the Chief of Engineers and the figures appear on page 3 of Part 2 in each case. In the annual report of the Chief of Engineers for the year 1935 it is stated on page 3:

"The gross total commerce on the rivers, canals, and connecting channels was 215,146,078 tons valued at \$3,973,683,002, which included 608,515 tons of foreign imports, valued at \$18,983,258, and 644,331 tons of export, valued at \$42,937,637. After eliminating all known duplications of traffic between different rivers, canals and connecting channels, the adjusted total amounted to 194,786,428 tons, valued at \$3,462,517,009."

That figure of 194,786,428 tons is the figure I used in my statement for the calendar year 1934 which is the period covered by Defendants' Exhibit 30. On page 3 of the commercial statistics of water-borne commerce for the United States for the calendar year 1933 appearing in the annual report of the Chief of Engineers, 1934, it is stated:

[fol. 1799] "The gross total commerce on the rivers, canals, and connecting channels was 199,558,245 tons, valued at \$3,436,292,381. After eliminating all known duplications, of traffic between different rivers, canals and connecting channels, the adjusted total amounted to 182,965,000 tons, valued at \$3,088,615,000".

In the annual report of the Chief of Engineers, United States Army for 1933, Part 2, page 3, it is stated:

"The gross total commerce on the rivers, canals and connecting channels was 165,338,881 tons, valued at \$2,983,203,487. After eliminating all known duplications of traffic between different rivers, canals and connecting channels, the adjusted total amounted to 151,276,145 tons, valued at \$2,589,991,917."

And in the annual report of the Chief of Engineers for the year 1932, page 3, it is stated:

"Gross total commerce on the rivers, canals and connecting channels was 206,883,274 tons, valued at \$3,156,734,169. After eliminating all known duplications of traffic between different rivers, canals and connecting channels, the adjusted total amounted to 179,735,000 tons, valued at \$2,816,403,000."

The rate of growth of traffic as shown by the figures on Defendants' Exhibit 30 for the period from 1932 to 1934

is 30.3%. Using those figures and eliminating duplications, the rate of growth for the same period was 28.5%.

“Q. Now, the defendants have testified that the elimination of duplication would not change the 1950 traffic predicted. What are your views with respect to that?

Mr. Fly: I object to his views. That is just simply a question of fact. If he knows the fact, let's find out how he knows it.

Judge Allen: Objection sustained. It falls within the ruling of the Court.

Mr. S. D. L. Jackson: If I might state, I think that is merely just a mathematical computation based on the same basis as this exhibit 30, but using different figures than those used in Defendants' Exhibit 30, but if I may be permitted to save an exception and state very briefly, I can clear it up.

[fol. 1800] If the witness were permitted to answer he would state insofar as the figures shown on Defendants' Exhibit 30 control the estimate for 1950 traffic, the use of figures eliminating duplications would result in a lower estimated traffic for 1950 as the rate of growth would be less.

Q. What general classes of traffic are included in the annual reports of the Chief of Engineers under the caption, 'Grand total, rivers, canals and connecting waterways' which the graph entitled 'Total traffic inland waterways' on Defendants' Exhibit 30 purports to illustrate?

Mr. S. D. L. Jackson: I might say, if the Court please, that all of this testimony is directed to inaccuracies that appear, inaccuracies of fact that appear on Defendants' Exhibit 30, which was offered and received in evidence here after being offered by the defendants.

Judge Allen: To illustrate an opinion.

Mr. S. D. L. Jackson: Facts on which——

Judge Allen: Is that so?

Mr. S. D. L. Jackson: —an opinion was based. And also, it is an exhibit which graphically shows certain things.

Judge Allen: To illustrate an opinion.

Mr. S. D. L. Jackson: I don't know as Defendants' Exhibit 30 is merely to illustrate an opinion. It purports to portray facts, if your Honor please. It purports to show gross water-borne commerce on inland waterways of the United States, and here is a graphical representation of it. Does

the Court have this in mind, that we are alluding to, in this evidence (indicating)? That doesn't show opinion, that purports to show facts, and they are wrong.

Judge Allen: What witness introduced this exhibit, Mr. Jackson?

Mr. Fly: It was Colonel Watkins.

Judge Allen: Are these actual figures on this graph? Where did he claim he got them?

Mr. S. D. L. Jackson: He got them from reports of the Chief of Engineers and other official reports.

Judge Allen: It is not a conclusion of his—

Mr. S. D. L. Jackson: No, your Honor, it portrays facts graphically.

[fol. 1801] Judge Allen: Obviously, the present question is directed toward the navigation phases of the case.

Mr. S. D. L. Jackson: Yes, your Honor, and particularly with reference to an exhibit relating to that introduced by the defendants, which purported to show facts.

Judge Allen: The exhibit being introduced by a witness who was an expert, and who gave his opinion, we feel that this falls within the ruling previously announced, and also, we bear in mind this statement in the *Ashwander* case:

'While, in its present condition, the Tennessee River is not adequately improved for commercial navigation, and traffic is small, we are not at liberty to conclude either that the river is not susceptible of development as an important waterway, or that Congress has not undertaken that development.'

That is 297 U. S. Reports. Now, in view of that statement, the Court considers that this particular line of questioning is immaterial. We consider that it was immaterial in the first place, it was immaterial in the defense, and it is immaterial now.

Judge Allen: The Court indicated last night very plainly that we felt that the spirit of our ruling has been violated during the day, but we realized that you were in a situation where you had your questions prepared in a certain way, and could not possibly do that. We asked you to change that today, bearing in mind the spirit of the ruling as well as its letter. The spirit of the ruling excludes the interminable minutiae upon which these opinions are based.

Mr. S. D. L. Jackson: Now, if the Court please—

Judge Allen: You are trying to break down Colonel Watkins' opinion, and show that it is not credible—

Mr. S. D. L. Jackson: No.

Judge Allen: That it is based on improper figures and values. Why can't you say on the record that the Court would not hear you further on that, and that you excepted vigorously? Now, doesn't that show the Supreme Court what that is about?

Mr. S. D. L. Jackson: I don't believe it does, if your Honor please. I will be glad to try to make a statement now which will bring this out, but I know of no other way of doing that but to bring another question before the Court for ruling, ask the question, and if objection is sustained, then, I will attempt to state it as briefly and in the shortest possible [fol. 1802] form as possible. I worked and tried to revamp this material so as to comply with the Court's ruling yesterday, both in the letter and spirit of the ruling. If permitted to go forward with that, I think I can probably get this evidence in, if the Court will permit, and also make a record which will be satisfactory to our clients, in a very short space of time, rather than as we did yesterday, spend considerable time attempting to discuss it. I have tried to boil this down so that both those results can be achieved and still conserve the time of the Court and counsel to the utmost.

Judge Allen: The objection is sustained. We feel that it is within the spirit of the ruling made yesterday, we consider that it relates to a line of immaterial inquiry.

Mr. S. D. L. Jackson: May we have an exception? Now, in attempting to state briefly and succinctly the matters I would expect to develop on this line of examination, and in answer to this particular question, if the witness were permitted to answer he would state that over 50 percent of the total traffic carried on rivers, canals and connecting waterways, consists of deep draft ship traffic as of the total given in Defendants' Exhibit No. 30, that there is no relation between the growth of deep draft ship traffic and that which might utilize a nine foot channel on the Tennessee River; that deep draft traffic is partly foreign, partly domestic, moving over ocean routes or deep draft areas where conditions as to cost are different, and in ocean traffic, competition is between water carriers only, and the same is true for domestic coastwise traffic, whereas, on strictly inland waterways, the principal element of competition is that offered by land transportation.

Q. Major Putnam, to what extent, if any, does the availability of raw materials and markets enter into a comparison of traffic growth on one group of waterways with the possible growth on another? If the Court please, I realize that calls for an opinion, and I have a statement prepared.

Mr. Fly: We object.

Judge Allen: Objection sustained.

Mr. S. D. L. Jackson: Please note my exception. If the witness were permitted to answer this question and other proper questions, he would state that the factor of the availability of raw materials and markets materially affects the comparison of traffic growths on inland waterways, as contrasted to deep draft ship traffic waterways. To compare the Tennessee River with the Great Lakes would be to assume that the cost of producing and assembling iron ore, [fol. 1803] coal, limestone and other raw materials of the steel industry at one or more points on the Tennessee River, would not be greater than that now resulting from the use of the Great Lakes. No such equal basis exists, and could not unless high grade iron ore could be produced in the Tennessee basin, and unless a project depth of 21 feet or more were provided on the Tennessee River, with locks throughout large enough to accommodate ships over 600 feet long, and 60 to 70 feet wide. That as to markets reached by water, other than local markets, for which the Great Lakes routes have the advantage, the Chicago district is about 363 miles by water from St. Louis, while Chattanooga is 701. Pittsburgh is about 472 miles by water from Cincinnati, and 608 from Louisville, while Chattanooga is 929 and 795 miles respectively from these two places.

Q. Major Putnam, witness Watkins, Defendants' witness, Colonel Watkins, estimated that the existing traffic on the Tennessee River of about 2,000,000 tons would increase to 17,700,000 tons about 1950. Assuming the TVA projects for the Tennessee River were now just completed and ready for use, what rate of increase would be involved to reach that total by 1950?

Mr. Fly: I object to that as improper rebuttal.

Judge Allen: It calls for an estimate, does it not?

Mr. Fly: Anyone with a pencil can figure that out, so why take the time of this Court?

Mr. Fitts: He went into traffic estimates at great length on the case in chief.

Judge Allen: Objection sustained.

Mr. S. D. L. Jackson: Exception. If permitted to answer, he would state 65½ per cent each year.

Q. Assuming that the TVA projects were not completed until the end of the year 1943, the date scheduled in TVA's report to Congress of March, 1936, what rate of increase would be required to meet the 1950 figures?

Judge Allen: Objection sustained.

Mr. S. D. L. Jackson: If permitted to answer, he would state 131 per cent each year.

Judge Allen: Mr. Jackson you did not understand that the ruling yesterday precluded other types of rebuttal than that covered by the ruling?

Mr. S. D. L. Jackson: I think this is under the ruling. This is merely to clarify matters that are already in the record. It is concentrating and making a calculation which might be of assistance to the Court.

[fol. 1804] Judge Allen: The objection is sustained.

Mr. S. D. L. Jackson: The offer has been made. Exception.

Q. What has been the average rate of increase of traffic on the Ohio River from 1932 to 1935?

Mr. Fly: The same objection.

Judge Allen: Objection sustained.

Mr. S. D. L. Jackson: Exception. If permitted to answer, he would state the rate of increase has been at the rate of about 15.5 per cent a year. Now, I don't desire to impose on the Court, but I have a very few questions to develop, and I can make the record very promptly.

Q. What was the total traffic on the Ohio River for 1935?

Mr. Fly: The same objection.

Judge Allen: Objection sustained.

Mr. S. D. L. Jackson: Exception. If the witness were permitted to answer, he would state about 22,138,000 tons, including ferry traffic.

Q. What would be the traffic on the Ohio, or what would the traffic on the Ohio have to be for 1937 to have increased since 1932 at the same rate required for existing traffic on

the Tennessee River to reach the 1950 predicted figure in the period from the end of 1943 to the end of 1949?

Judge Allen: The objection is sustained. This really amounts to a reopening of the case.

Mr. S. D. L. Jackson: Now, all this is, if your Honor please, it is just a few mathematical computations based upon figures that are here. And the computations we felt would be of assistance to the Court in considering this evidence, but if the Court does not desire us to present them, we won't, but it will only take a moment, I assure you. We don't feel that it is invading the Court's previous ruling on rebuttal. I think it might be somewhat inconsequential, but it is not going behind the Court's back in any way. The whole purpose of it is to assist the Court. I realize the Court can make these computations, if it desires to do so. This is merely to present a figure.

Judge Allen: The objection is sustained. Of course, we realize it is not going behind our back, because we realize the important audience is the Court Reporter.

[fol. 1805] Mr. S. D. L. Jackson: If permitted to answer, the witness would state the Ohio River traffic would have to total approximately 118,600,000 tons for 1937 under that assumption as to rate of growth.

Q. When you made your traffic survey for the Illinois River, as published in House Document No. 4, 69th Congress, First Session, what traffic did you estimate would move on that stream, in that document?

Mr. Fly: I object as irrelevant and immaterial, as well as improper rebuttal.

Judge Allen: Objection sustained.

Mr. S. D. L. Jackson: Exception. If permitted to answer, he would state 7,515,000 tons a year.

Q. Did the traffic spring into existence the year the waterway was completed?

Mr. Fly: Objection.

Judge Allen: Objection sustained.

Mr. S. D. L. Jackson: Exception. If permitted to answer, he would state that it did not, but starting with the year 1933 the traffic increased from 194,000 tons for the previous year to about 389,000 tons. By the year 1935 it in-

creased to about 620,000 tons, and preliminary estimates for 1937 place the traffic at something above that.

Q. This is a different line, directed to the testimony of the witness Alldredge. Defendants have testified that existing transportation savings by water on the Tennessee River—and I refer you to defendants' exhibit 128, it was generally assumed that the water or rail-water transportation charges would be 80 per cent of the corresponding rail charges. In connection with existing operations on other portions of the Mississippi system, to what classes of water carriers, if any, does a formula of that kind apply?

Mr. Fitts: We object to the question as improper rebuttal. The testimony of Mr. Alldredge was in reply to the testimony of this witness.

Mr. S. D. L. Jackson: I think Mr. Alldredge is the first one who went into these rail-water combinations though.

Judge Allen: He testified he made his computations on the basis of 80 per cent, didn't he?

Mr. S. D. L. Jackson: That is correct, he did.

Judge Allen: And he made estimates on that basis.

Mr. S. D. L. Jackson: Well, I don't know if they are estimates, or whether he made calculations, but he drew conclusions from them.

Judge Allen: Objection sustained.

[fol. 1806] Mr. S. D. L. Jackson: May I have an exception. If permitted to answer, the witness would state such a formula applies only to common carrier transportation, and then only to the portion of their business which is rail-water interchange traffic. And one following question on the same point.

Q. What per cent of the total traffic shown on defendants' exhibit 126 is comprehended by the terms of traffic to which this formula was applied?

Mr. Fitts: The same objection.

Judge Allen: The same ruling.

Mr. S. D. L. Jackson: If the witness were permitted to answer, he would state about 41 per cent. And may we have an exception to the ruling?"

The Federal Barge Line or The Inland Waterways Corporation operates on the Mississippi River between the Twin Cities and New Orleans, on the lower section of the M

souri River, below Kansas City, and on the Illinois waterway between the mouth of the Illinois and Chicago, and also on the Warrior River system.

Cross-examination:

It does not operate on the Ohio, unless the terminal in the City of Cairo is across the state border, which I don't know. It does not go to Louisville.

Direct examination continued:

The Inland Waterways Corporation handles chiefly common carrier business. About 4 per cent of the total traffic on the inland waterways consists of common carrier business and about 5 per cent of the total business on the Mississippi system is common carrier business.

"Q. Now, based on experience elsewhere, is it fair to assume that about 41 per cent of the future traffic of the Tennessee River will be common carrier business?"

A. It is not fair to so assume.

Judge Allen: Wait a minute.

Mr. S. D. L. Jackson: Mr. Fly is resting over here.

Mr. Fitts: We didn't object.

[fol. 1807] Mr. S. D. L. Jackson: It does call for an opinion.

Judge Allen: The Court sustains an objection on its own motion.

Mr. S. D. L. Jackson: I am merely making my record on this question. It is the only one I have on this particular point. There was a ruling?

Judge Allen: The Court of its own motion sustained the objection to that question.

Mr. S. D. L. Jackson: If I may have an exception. If the witness were permitted to answer, he would state, 'it is not'."

The table (offered and received in evidence as Complainants' Exhibit 932) shows the comparative times for a single lockage through locks of two different sizes, that is 60 by 360 feet of the TVA above Wilson and 100 by 600 below Wilson. There is a third alternative using low lift lock 110 by 600 feet which has a differential in time. It gives the separate operations for each type of lock for single lockage.

The table (offered and received in evidence as Complainants' Exhibit 935) gives the figures showing the total time in hours consumed with the low dam plan or with the TVA plan. It is based on the times which are totaled at the bottom of Exhibit 932, using these unit times for each of the locks through either plan and taking into consideration the number of locks and open river navigation. There are two assumptions involved. One assumption is that we use a smaller size tow that would go through a single lock the whole length of the river, which is called the Hales Bar Lock size tow, which would be the controlling locking size. The other estimate is for an eight-barge tow, which is described or referred to by the defendants in their testimony. I assumed on Complainants' Exhibit 932 that an eight-barge tow has to go through the small lock in three sections. The 116 minutes which you see on the right hand column on Complainants' Exhibit 935 is the total time shown on the previous Exhibit of 116 minutes where each operation is [fol. 1808] detailed and where the eight-barge tow must go through in three operations, four barges each time and then the tow-boat the last time. There is not room for the five units in the lock at once.

"Mr. S. D. L. Jackson: If the Court please, I have one question of an opinion nature which I would like to be permitted to ask, to make a record.

Judge Allen: It is based upon these exhibits?

Mr. S. D. L. Jackson: Yes, it is directly based upon the exhibits and the explanation that the Major gave with reference to them. I am merely asking for my right to make my record. It is clearly an opinion question that I am asking.

Q. Major, what difference, if any, exists in the cost of transportation of freight by water as between the use of tows of the size suitable to pass at Hales Bar Lock, with breaking the eight barge tow previously described?

Mr. Fitts: We object to that, may it please the Court.

Mr. S. D. L. Jackson: That eight barge tow is in evidence.

Mr. Fitts: Yes, he asked for the difference in cost of transportation. Isn't that your question?

Mr. S. D. L. Jackson: That is right.

Judge Allen: The objection is sustained. In other words, the Court has asked for the exhibit, but these questions we consider to be within the ruling.

Mr. S. D. L. Jackson: I apprehended that ruling. I merely wanted to save an exception. If the witness were permitted to answer he would state there would be a savings in transportation costs of at least 15 per cent in favor of the eight barge tow. I have one further phase to take up, if the Court please, and I will be just as expeditious as possible in covering it.

Q. Major Putnam, defendants have testified with respect to their Exhibit 115 to the effect that the average current velocity in the Tennessee River throughout the entire length for 100 per cent of the time amounts to two miles per hour under the low dam plan; also that under the TVA Unified Plan the average current velocity throughout the entire river for 100 per cent of the time would be 5/10ths of a mile per hour. What ratio is this between the average current velocities of the two plans as testified to by the defendants?

[fol. 1809] Mr. Fitts: What is that? That calls for just a computation.

Mr. S. D. L. Jackson: This does. This one question is merely preliminary.

Mr. Fitts: We object to it on the ground it is cumulative and unnecessary in any event, besides being improper rebuttal.

Judge Allen: The objection is sustained.

Mr. S. D. L. Jackson: May I have an exception, and if the witness were allowed to answer this question and other appropriate questions on the same subject, he would have testified. I will state that this is an offer to prove which we make, had we been permitted to conduct a line of examination of Major Putnam on matters of speed, depth, and current velocity, and a comparison of the respective speeds and current velocity, under the two plans. If this witness were allowed to answer this question and several other questions of a similar nature dealing with the same subject, he would have answered as follows:

Defendants' Exhibit 115 contains a statement to the effect that the current velocity throughout the entire Tennessee River for 100% of the time would be 2 miles per hour as compared to the current velocity under the TVA plan of .5 of a mile per hour. This statement as to average current velocity under the low dam plan is incorrect as shown by the results of a study of Defendants' Exhibit 106 which shows a ratio of current velocity between the two systems for dif-

ferent lengths of the river for different percentages of the time. A study of this Exhibit 106 shows that the ratio between the average current velocity under the low dam system to that under the high dam plan system should be in the neighborhood of $2\frac{1}{2}$ to 1 and not in the ratio reflected in the statement, Defendants' Exhibit 115, which is 4 to 1.

If allowed to answer the next question, the witness would have stated that his investigations show that for the entire river the average duration of the period when the wickets are lowered would be 30.8% of the time. During that average period the current velocity would average 2.06 miles per hour. With the individual wicket dam pools, the velocity range would be from 1.48 miles per hour to 3.03 miles per hour, these partial velocities having a duration of 13%. For these pools, the duration range is from 8% to 67% and the current velocities corresponding to these durations are 2.36 miles per hour and 1.76 miles per hour. Current velocities which might be termed to be quite high, that is, those over 3 miles per hour, are of short duration.

[fol. 1810]—If the witness had been permitted to answer the next question, he would have stated that the statement on Defendants' Exhibit 115 quoted as follows: 'The upstream running times are based on a still water towing speed of 5.5 m.p.h. minus current velocity of 2 m.p.h. with the low dams and minus 0.5 m.p.h. with the high dams. The down stream running times are based on a still water towing speed of 5.5 m.p.h. plus $\frac{1}{4}$ of the current velocities,' is an incorrect statement of method of allowing for increased speeds resulting from current velocities because it is not correct to state that the down stream speed should be increased by adding $\frac{1}{4}$ of the current velocity to the still water speed. If channel conditions are such that a tow can travel at any given rate of speed, then it can do so if the still water speed plus the current velocity is equal to or greater than the rate of speed allowed by channel conditions and is in no way dependent upon current velocity.

If permitted to answer the next and other questions of a similar nature relating to the same subject this witness would have testified that the only place where the low dam plan would have provided just barely a 9-ft. depth was on the intermediate sill of the lock at Wilson Dam and that this limiting depth would control the draft of vessels for either the low dam project or the TVA dam project. A re-

sult of this would be that the TVA project would not allow a 9-ft. draft for vessels navigating the Tennessee River.

If permitted to answer several other questions of a similar nature dealing with the same subject, this witness would have stated that Defendants' Exhibit 107 did not represent the latest authentic data with respect to matters affecting the relation existing between depths of water, speed of vessels, and indicated horse power. The supporting data for Defendants' Exhibit 107 was published in 1921, and numerous tests and observations have been made since that time which support the modern finding to the effect that increasing the length of a tow can be expected to offset friction resistance due to shallow water. He would further have testified that there is no value in depths of water in excess of 15 feet as far as their effect upon the resistance to movement of large tows on the Tennessee River is concerned.

If permitted to answer the next question and other questions of a similar nature on the same general subject this witness would have testified that based upon Defendants' testimony as to the length of the river under the low dam plan which would consist of dredged channels and as to the duration of increased depths due to high stages of the river there would be no value in the increased depths provided by the TVA plan for 50% of the time. He would also have testified that for the other 50% of the time when the increased depths over the bars in the low dam plan would be less than 4 feet for 20% of the distance as testified to by Defendants that the TVA plan would have an advantage [fol. 1811] of an increased speed resulting from the greater depths of not over 10% for 20% of the distance for 50% of the time or the equivalent of an increased speed of 1% as applied to the entire river for the entire year. He would also have testified that for the 80% of the river not involved in dredged channels, no greater speeds would result to either plan because depths would be generally in excess of 15 feet. If barges were partially loaded or were running light, the 1% advantage would be decreased.

If permitted to answer the next question, the witness would have stated in rebuttal to Defendants' testimony to the effect that a vessel that was foundering would have no more difficulty in getting out of deep water in order to be beached before sinking with the TVA plan than it would with the low dam plan, that the increased distance to travel

under the TVA plan would be almost half a mile or nearly 3 times as much as that involved under the low dam plan.

Judge Allen: Mr. Jackson, you have shown that you now understand what the Court has been trying to do with reference to this question of offer of proof, and I might say our desire for expedition is not a desire for expedition wholly for the Court. It is a desire for expedition for the sake of counsel. Since we now understand each other, if you wish to amend, or move to amend the offer of proof, which the Court made from the bench here yesterday, on certain questions that you were not permitted to ask, in an effort to show how it could be done, the Court will consider that.

Mr. S. D. L. Jackson: Thank you, your Honor, for that. Judge Allen: You could do that during recess.

Mr. S. D. L. Jackson: I would be very glad to, to check the record. And I had caught last night, in going over my notes, certain matters of offers to prove, which I had stated, which I was going to request the indulgence of the Court to permit me to augment slightly by the addition of a sentence or two, and I will be very glad if I may also examine during the recess, or perhaps during the noon hour, the offers of proof stated by the Court in certain instances, and do it all in one statement this afternoon, if I may. In connection with the subject of stage fluctuation at terminals, on which there were one or two questions yesterday, I note that I offered to prove—an offer to prove which I had made appears in the record as being partly stated before the noon recess and partly after the noon recess, and part of it unfortunately was not stated at all. If I may be permitted to ask this witness one or two questions on this general subject, then I want at that time to introduce or to specifically call the Court's attention to a page or two of an exhibit that is already in evidence in connection with that examination." [fol. 1812] With reference to stage fluctuations at terminals, changes in the stages in excess of 4 feet a day for the period from 1925 to 1934, inclusive, averaged at Florence, Alabama, 1.9 days per year, at Johnsonville, Tennessee, 4.2 days per year and at Chattanooga, Tennessee, 7.9 days per year. Pages 188 and 189 of House Document 328, Complainants' Exhibit 105, gives the extreme ranges produced by flood stages in the four important points on the Tennessee River of Knoxville, Chattanooga, Florence and Johnsonville. (Counsel for complainants then offered in evidence

and the Court received photostats of pages 188 and 189 of House Document 328 which is Complainants' Exhibit 105.)

"Q. Would any enrichment of the low water flow which would be provided by the TVA Unified Plan eliminate or decrease the cost of dredging operations on the Mississippi River?

Mr. Fitts: We object to that question. The exact same question was asked on the examination of Mr. Putnam before in the case in chief.

Judge Allen: It calls for an opinion, does it not, Major?

Mr. S. D. L. Jackson: It does.

Judge Allen: Objection sustained.

Mr. S. D. L. Jackson: May I have an exception and offer to prove there would be no decrease in cost of dredging operations on the Mississippi River? Will you mark this as exhibit 936?

One final question. I have asked the reporter to mark as Complainants' Exhibit 936 House Document 306, 74th Congress, First Session, concerning which there was some testimony yesterday about this, testimony or offers to prove, about this wicket dam construction of dams in the Ohio River. And I offer that exhibit in evidence. That is the book.

Mr. Fly: We object to this, your Honor, on the ground first that it is not proper rebuttal, and further it is cumulative if it has any bearing at all. We further object to it on the ground of relevancy.

Mr. S. D. L. Jackson: I think that yesterday counsel asked us to produce and introduce the whole exhibit.

Mr. Fitts: We said if there was going to be any evidence on the subject at all.

Mr. S. D. L. Jackson: There has been some evidence.

[fol. 1813] Mr. Fitts: The evidence is wholly immaterial.

Mr. Fly: I objected to the witness testifying as to the contents of a document. I did not thereby stipulate the whole document became admissible at this stage of the proceedings.

Mr. S. D. L. Jackson: In any event, we offer it, your Honor.

Judge Allen: The exhibit is rejected.

Mr. S. D. L. Jackson: May we have an exception?

Judge Allen: You may."

(Subsequently at the close of the trial, the Court permitted further offers of proof to be made by counsel for complainants in connection with this testimony as follows):

"Mr. S. D. L. Jackson: In response to appropriate questions put to the witness Rufus W. Putnam, the witness, if permitted to answer would state that in designing a lock the practice with reference to considering the time of filling and emptying is to design the valves, culverts and openings into the lock chamber of such dimensions and spacing as to let water in as fast as possible without creating disadvantageous surges; that where the surge is too great a disturbance is created which may damage vessels using the locks and the lock walls through collision; that also tow lines are likely to be parted resulting in additional delays at the locks. Further, in assuming that two locks are capable of being filled at an equal rate as far as length and width are concerned, it is necessary to design the lock with the higher lift so as to let in water at a much faster rate in order to permit of the filling of each of such locks in the same time.

The witness Putnam, in answer to appropriate questions, would further testify in rebuttal to the testimony of the witness Barker, appearing at page 4637 of the (stenographic) record, that the practical working capacity of the existing locks at Dam No. 1, Wilson and Hales Bar is 40 per cent of the theoretical capacity of such locks, that twin locks, each 56 feet by 360 feet have been available on the lower Monongahela River for many years, that since 1923 the Corps of Engineers has lengthened some of the lower locks to 720 feet to increase their capacity, that the theoretical maximum capacity of one of these sets of locks is about 125,000,000 tons a year and the maximum commerce passing through such locks was in 1929, and amounted to about 28,900,000 tons, or about 23 per cent of the theoretical working capacity as compared with the 40 per cent figure testified to by the witness Barker. The witness Putnam, in answer to appropriate questions would testify in rebuttal to testimony from the witness Watkins, appearing at page 3272 of the (stenographic) record and the witness Barker, [fol. 1814] appearing at page 4604 of the (stenographic) record, that the daily fluctuations in excess of two feet at Florence would occur on the average of about 16.2 days per

year, at Johnsonville, 27.7 days per year, at Chattanooga, 32.2 days per year, that such figures are based upon the examination of the daily hydrographs for the ten year period, 1925 to 1934, both inclusive.

The witness Putnam, in answer to appropriate questions, if he were permitted to answer, would testify in rebuttal to testimony of the witness Watkins, on pages 3274-3275 of the (stenographic) record and the witness Barker, on page 4715 of the (stenographic) record, that under the TVA Plan there will be about 138 miles where there is a wide open sweep and cross winds. Under the low dam plan there will be little or no channel exposed to a wide open sweep and there will be nearly 184 miles of channel within the banks of the river, of which about 130 miles will have a width of 400 feet or more; that the channel within the banks in each case will be of equal conditions as respect to cross winds except for the 54 miles of low dam channel which will be less than 400 feet in width; that it is necessary therefore to compare the effects of cross winds for 54 miles of channel, less than 400 feet in width, in the low dam plan with those for 138 miles of TVA channel exposed to wide open sweeps. Whatever difference exists is in favor of the low dam plan.

I wish to direct the Court's attention to the top of page 212 of Exhibit 105 with reference to the 9-foot depth on the intermediate lock sill at Wilson. The witness Putnam, in response to appropriate questions would, if permitted to answer, testify in rebuttal to the witness Watkins' testimony, at page 3301, the witness Barker, at pages 4653 and 4654 and the witness Brodie, pages 4909-4912 (of the stenographic record), that the benefit of the release of stored waters to navigation on the Ohio and Mississippi Rivers would be so small that it would be impossible to calculate it, and would have stated his reasons in support of this opinion as follows: The Tennessee River is the River that is proposed to be regulated by TVA, not either the Ohio or the Mississippi Rivers. As a result the coincidence of low water on the Tennessee River with that on the other streams is very limited. Any possible enrichment as a result of storage releases from the tributary reservoirs on the Tennessee is only a small percentage of the low water flow on the Mississippi, which has averaged 134,000 cubic feet per second during a recent thirty year period.

Any increases in stage resulting will vary daily, weekly, monthly and annually, cannot be predicted on the Mississippi or Ohio Rivers nor anticipated. The stage increase [fol. 1815] resulting would be possibly of a small value in places only where the depths of less than 15 feet would be available in the natural river as most of the river consists of deep pools. Any stage increase at Cairo becomes smaller in amount proceeding downstream towards the mouth of the river.

If the regulation of the Tennessee River were to produce minimum weekly flows as set forth by TVA on page 59 of the Unified Report to Congress in March 1936, the stage increase on the Mississippi would average not to exceed 1.2 feet for only 6 per cent of the time based on an examination of a thirty years record of daily flow of such stream. This increase would not have exceeded two feet for one day in the entire thirty years period. It would have been between one and a half feet and two feet for 112 days during that period and in excess of one foot for 505 days. An increase in stage of 1.2 feet on the Mississippi results in increased depth of only eight inches due to the peculiar behavior of bar formations on the Mississippi River.

The witness Putnam in response to appropriate questions would, if permitted to answer, testify that the construction of low dams would not in any way affect the possibility of subsequent erection of high dams unless they were located on the exact sites proposed for the high dams; that if both types of structures were to exist simultaneously, the pools would be kept confined to low dam pool stages except in times of flood. During floods, the navigable passes would be lowered and navigation would operate as with the high dam system, through locks in the high dams.

An arrangement similar to this was proposed in Complainants' Exhibit 105, House Document 328, for the extension of reliable navigable depths in the upper portion of what is now Norris Reservoir, so as to overcome the differences between low pool and high pool stages for carrying navigation through to the upper end of this navigable stream, which otherwise could not be reached by navigation during maximum drawdown periods."

Cross-examination:

I would not say I have been present in Court a large part of the trial, certainly not half of it. I have been in Chattanooga during most of the trial. I have acted as a consultant for complainants and their counsel continuously since the beginning of the trial but not continuously prior thereto. I have advised with counsel in the course of the examination and have sat at counsel's table during the examination of the defense's hydraulic witnesses and have [fol. 1816] actively advised counsel and suggested questions to counsel for cross-examination of a great many of the defense's engineering witnesses.

I have not chosen the four cities on the Tennessee which have the least fluctuation—some of them have small fluctuations and some of them have larger fluctuations. Most of those cities do not have the least fluctuation of any cities on the river. Sheffield has lesser fluctuation and there are some small points up near the mouth of the Clinch, Kingston and Lenoir City that will be found to have less fluctuation, I think, than Chattanooga. Those cities are among the cities that have the least fluctuation on the Tennessee River. I do not have the details of how many days in the year the average fluctuations in stage at Guntersville and Decatur, Alabama, are in excess of four feet. I will have to work that out. I would not know without an examination of the hydrograph whether it is very much larger. My opinion without any basis of anything else but general knowledge of the situation on the river is that it would be greater, but I don't know how much. All those cities selected by me are at the upper ends of pools except Johnsonville. You would not necessarily have smaller fluctuations at the shallow ends of the pool. There will be smaller fluctuation at steeper places in the river. Florence and Chattanooga are located at steeper places in the river, Knoxville is in a comparatively flatter section and Johnsonville on the lower section of the river is in an even flatter section than the others.

I did not refer to any project located in the vicinity of St. Paul. I referred to a low dam project between St. Louis and St. Paul. The project extends from below the mouth of the Illinois River at Alton to the head of navigation at Minneapolis. I don't recall referring to any one [fol. 1817] movable dam, either installed or being installed

in that region. As I recall it, practically all of the dams of the 26 in that region are movable dams. I was asked whether I knew there was a low dam project under construction by the Corps of Engineers. I did not mean to suggest to the Court that the dams under construction were similar to the low dams in House Document 328. They are movable dams in the sense that the discharges and flow are controlled by Taintor gates or roller gates. In order to keep the pools at a very close degree of regulation, these gates are installed as a necessity to control the pool levels very closely, due to railroad, city and other occupation on the banks. As to whether that makes it a movable dam, I would call that a movable dam. I would not think it to be a fact that the usual definition of a movable dam refers to the wicket type of dam. The wicket type of dam was the type set forth in House Document 328 under the low dam scheme. The dams that I have reference to have a regulation type of lock in the sense that a vessel has to lock through. They have no navigable pass. I have never understood a gate of the size there to be a spillway. It is a difference in terminology. It is for the regulation of pool levels, whether water is discharged or not. I would not attempt to compare the two types.

I testified as to one other recommendation with which I was familiar—that proposal was for the replacement of five of the wicket dams now in existence on the Ohio River with wicket dams of two feet higher lift and probably for strengthening of the foundation and lengthening of the wickets, which would involve a complete replacement of that section of the dam. I merely meant to suggest to the Court that this was an illustration of the fact that at least certain members of the Corps of Engineers did not think wicket dams are obsolete. I did not mean to testify that those dams were eliminated or replaced. What was [fol. 1818] actually done there was that there was a slight increase in the height of lift by substantial reconstruction. One of the principal objects was to increase the depth of the water in back of the dam. I did not intend to change the testimony I gave in this case originally as to the practice of the Corps of Engineers in substituting higher dams in place of the low dams.

In the design and construction of new equipment for inland waterways in certain operations where the volume

of business would justify, there is a general tendency towards heavier and more expensive units.

"Q. Is it not true that the Federal Barge Lines operate several different types of equipment?

A. That is correct.

Q. And it is true, is it not, that on the upper Mississippi they have in use small equipment similar to the equipment in use by other operators?

A. They have small equipment; as to its comparative weight with that of other operators, I am not in position to state.

Q. Well, in general it is about the same type, isn't it?

A. I would not know in detail; I have not examined the structural details of those barges.

Q. I would not ask you in detail, I would ask you in general.

A. In general, I think those barges are slightly more expensive.

Q. Only slightly?

A. As I spoke of yesterday.

Q. But only slightly in that instance?

A. Yes sir; they have very fine equipment."

As I recall, there is coal near LaFollette, Tennessee. I will have to refer to my notes to be sure. It is one of the coal mining centers. I did not particularly note that House Document 328 indicated the existence of substantial amounts of coal located on the Clinch River above Norris [fol. 1818a] Dam. On plate 180 of Part II of that document, the coal operations appear to be largely north and northwest of the Powell River and very few on the Clinch.

Redirect examination:

The average lift of the 26 dams on the Mississippi River, including the high lift dam at the Twin Cities, is 11.4 feet. The pools behind those dams are generally maintained within the banks of the river. There are a few places in the marsh sections near LaCrosse and Winona where it spreads out somewhat, but in general it is between the banks of the river. In the steep places in the river there is less fluctuation.

(The witness was excused.)

[fol. 1819] THEODORE T. KNAPPEN was called as a witness on behalf of the complainants and, having been first duly sworn, was examined and testified as follows:

Direct examination:

I am 37 years old, live in New York City, and am a civil engineer, I am graduate of the U. S. Military Academy, B. S. degree; a graduate of the Engineering School at Ft. Belvoir; and a graduate of the Rensselaer Polytechnic Institute with the degree of Civil Engineer. I served as First and Second Lieutenant in the Corps of Engineers, engaging in miscellaneous duties including surveying and construction, and I engaged in engineer work in California in construction and hydraulic mining. From July 1924 to March, 1925, I worked on the design of service water supply for Vallejo, Cal. From April, 1925, to May, 1928, I was the design and resident engineer on water storage development for irrigation and hydro-electric power for the Nevada Irrigation District. From June, 1928, to August, 1928, I was hydraulic engineer for the Hetch-Hetchy water supply project. From September, 1928, to March, 1934, I was area engineer for the 1st Field Area, Memphis Engineer District, with headquarters at Cairo. From April, 1934, to August, 1936, I was Chief of the Engineering Division of the Muskingum Flood Control Project in Ohio. From August, 1936, to July, 1937, I was consultant and chief of the flood control section of the U. S. Engineering Department, North Atlantic Division in New York City. From August, 1937, until now, I was and am a Consulting Engineer associated with the firm of Parsons, Clapp, Brickerhoff and Douglas on miscellaneous hydraulic and soils engineering work.

[fol. 1820] I am a member of the American Society of Civil Engineers and Secretary of the Soil Mechanics and Foundations Division of that society, and Chairman of the Subcommittee on the Structural Design of Earth Dams and Embankments, and am a member of the American Geophysical Union.

While Engineer of the 1st Field Area of the Memphis District, I was in charge of the design and construction of the New Madrid floodway, of the west levee from Cape Girardeau to the Missouri state line. The levees around Cairo and Cairo Drainage District and the levees from Hickman to Tiptonville, that is the Reelfoot levee district,

and I was in charge of all river work from Cairo to the Missouri state line, including bank revetment and contraction works and dredging. I was in charge of the construction, raising and maintenance of over 200 miles of levees under the Jadwin Plan, including the strengthening of levees and walls at Cairo and the Cairo Drainage District, and as area engineer was responsible for the acquisition of some 120,000 acres of land for levee rights. In dredging work I supervised the operation of from one to three dredges, a dredging survey boat and construction fleets, including up to 200 units of floating craft. I am familiar with the hydraulics of the Mississippi River at Cairo and the mouth of the Arkansas and I have substantial familiarity with the river below that reach. In connection with studies of hydraulics at Cairo, I became familiar with the main tributaries influencing the stage at Cairo, including the Ohio, Tennessee and Upper Mississippi.

As chief of the Engineering Division on the Muskingum Project, I was responsible for investigation, surveys, hydraulic studies, design and engineering supervision and I gave consideration to the major subjects of hydrology, [fol. 1821] project design, operating plans, economic studies and structural design, as well as other subjects, including the magnitude, duration and distribution of rainfall and the relation of rainfall to run-off and seasonal occurrences of floods. Floods selected for the basis of design for flood control projects were in excess of the greatest flood experienced in that watershed. I made special studies in connection with the design of the earth dams on the Muskingum Project which were erected on sand and soft foundations. As a consultant on the design of the Merrimac, Connecticut and Susquehanna River flood control projects, I considered matters of combined reservoir control, channel improvement and levee and wall protection. I am familiar with the design of hydro-electric reservoirs.

I am familiar with the reach of the Mississippi River extending from Cairo to the mouth of the Arkansas River and the flood control facilities that have been erected on that stretch.

"Q. Have you formed any opinions as to the most feasible types of projects for the protection of the alluvial valley on this reach in the event of overflow?

Mr. Fly: I object to that. Colonel Kelly came here and testified, and described the control works, described the alluvial valley and the works there, the Jadwin plan, and all of that, and gave his opinion as to all major aspects of this Mississippi Valley flood problem. I think this is entirely improper rebuttal.

Judge Martin: Brother Jackson, is any part of this proffered testimony through this witness more than cumulative?

Mr. S. D. L. Jackson: Oh, yes, if your Honor please, it is directed particularly to the testimony of several of the defendants' witnesses who were put on the stand, as to the effect on the Mississippi Valley of the flood control works which, as they have said, will include this new expanded Gilbertsville Dam, which of course was a deep secret from everybody when the complainants' case in chief was going in. If your Honors will note the exhibit introduced by—

[fol. 1821a] Judge Allen: I don't quite understand that, Mr. Jackson, because you certainly introduced reports, and you questioned upon Gilbertsville, and you put it on your maps, and you had it in your figures.

Mr. S. D. L. Jackson: The size and magnitude of the project, and its increased benefit on the Mississippi River Flood control; why, they have now put in a table, Exhibit 153, the last exhibit they put in, almost the last, which shows Gilbertsville with some 25% or more increased acre footage of flood storage, all of which, according to the testimony of these witnesses will serve to affect the flood control on the Mississippi River, and which no one knew until long after the plaintiffs' case in chief had been closed, and which first appeared when the defendants' witnesses got on this witness stand in the trial of this case.

Judge Allen: And you have in your hands the new reports, is that it?

Mr. S. D. L. Jackson: Yes, but that even never saw the light of day until December 13, and after we had closed our case.

Mr. Fly: Now, let's boil this down and see just what we have got hold of. That speech means that the adopted plan for the Gilbertsville project is 5 feet higher than counsel previously understood it to be. That is all, that is all there is to it.

Now, to take this witness and take him up and down the alluvial valley of the Mississippi, the levee system and the floodways, the floods, and flood damage, and all that sort of thing with a general question of that sort, because of five feet additional height on a single project, is utterly ridiculous, and that question cannot be aimed at that specific point.

Colonel Kelly testified as to all these projects, as to the whole valley and the entire business.

Mr. S. D. L. Jackson: I might state this five feet which counsel speaks of so slightly gives them a million and a quarter acre feet more flood storage, or so, they claim, and it appears in the figures that they themselves put in evidence.

Mr. Fly: I object to no questions specifically directed to the addition of the five feet at Gilbertsville.

Mr. S. D. L. Jackson: And its effect upon the Mississippi River.

Mr. Fly: The effect of Gilbertsville Dam, on account of the added five feet?

Mr. S. D. L. Jackson: The combined effect of that coupled, with the other things, on the Mississippi River presents [fol. 1821b] an entirely different situation.

Mr. Fly: That presents a wedge to get into the whole business, again, that is exactly what it presents.

Mr. S. D. L. Jackson: They present an entirely different situation than the old one.

Mr. Fly: That is a springboard to get into the old situation.

Mr. S. D. L. Jackson: I might say that if Mr. Fly will concede that the New Gilbertsville Dam will be of no more help to the Mississippi floods than the old Gilbertsville Dam, before they changed it, it will affect somewhat, our position on this trial.

Mr. Fly: I will concede that this witness, if called upon to testify, would testify that that added storage would give added benefit to flood reductions on the Mississippi River.

Mr. S. D. L. Jackson: That was not my question and although I appreciate counsel's desire to be helpful, I am sorry I cannot avail myself of it.

Judge Martin: Brother Jackson, could you for our aid, state generally what it is you expect to show by this witness?

Mr. S. D. L. Jackson: Yes, I will be very glad to.

Judge Martin: I don't think that is unreasonable.

Mr. S. D. L. Jackson: No, and I will be very glad to, if the Court please.

Now, I might state that in the witness' qualifications which are being copied into the record, and which the Court has not heard, it appears that among other things this witness was, for five years, in charge of an area in Mississippi, and has extensive and first hand personal information concerning it.

Mr. Fly: On the levees.

Mr. S. D. L. Jackson: Of the Mississippi and the flood control problems.

Mr. Fly: On the levees particularly. Isn't that correct, Mr. Jackson?

The Witness: On all phases of flood control.

Mr. Jackson: If you want to examine him about his qualifications, you can.

Judge Allen: Let's proceed. The Court, in addition to counsel, has been up and down the alluvial valley several [fol. 1822] times, and we want specifically to know, Mr. Jackson, from you, what is new in this subject.

Mr. S. D. L. Jackson: Now, specifically and in answering your question, your Honor's question, the purpose of calling Mr. Knappen is really a multiple purpose, first, that the testimony of the witness Kimball, which appears at page 4332 of the (stenographic) record as to his method of determining floods against which protection should be provided is fallacious and insufficient. At that point, Mr. Kimball, I believe, stated that he gave consideration only to floods of record in the Tennessee Valley and at page 4182 (of the stenographic record), that he did not give effect to the flood of 1867. Another purpose—

Judge Allen: That is an opinion of Mr. Kimball? The question seems to indicate so.

Mr. S. D. L. Jackson: I think, perhaps, it was an opinion based on researches and investigations of fact that he had made. An additional purpose is that contrary to the opinion expressed by the witness Clemens at page 3591 of the (stenographic) record and at page 4558 of the (stenographic) record by the witness Okey, that the most effective protection to the alluvial valley in the reach below Cairo against a flood of 2,600,000 cubic feet a second at Cairo would be the raising of the levees from 2 to 5 feet and

the improvement of the channel by cut-offs and the use of floodways. Now, these—

Judge Allen: This page 4558 of the (stenographic) record refers to an opinion, the statement is of an opinion.

Mr. S. D. L. Jackson: But, that opinion was based, I believe, in part, Mr. Okey's opinion, directly, was based on previous assumptions that had been given to him, and, I think, which will appear, after an examination of probably several pages, that he was considering Gilbertsville as having a very large—that is larger storage capacity available.

Judge Allen: Now, is there anything else?

Mr. S. D. L. Jackson: Oh, yes. That in addition that contrary to the testimony of the witness Clemens at page 3604 and 3605 and 3606, and the witness Okey at page 4506 to 4508, both inclusive (of the stenographic record), the Unified Plan of the TVA could not be depended upon to affect materially the crest stage reduction at Cairo in any great flood.

Judge Allen: You concede, of course, that the statement of that would be an opinion?

Mr. S. D. L. Jackson: Mr. Knappen's statement would be an opinion based upon the facts which he now has in-[fol. 1823] vestigated, and which he knows, and which are different than some of these other facts that were testified to as the basis for these other opinions.

Mr. Fly: I think it is always appropriate to bear in mind that our flood control witnesses were in direct answer to the flood control witnesses of the complainants. That was not new material on our part. Anything new is a mere matter of details and calculations, altogether—

Mr. S. D. L. Jackson: And facts.

Mr. Fly: — and that sort of thing.

Mr. Fitts: You opened the subject.

Mr. S. D. L. Jackson: Now, another purpose, that, whereas the testimony of the witness Clemens at pages 4221-4222 (of the stenographic record), indicate that a reduction in the crest of the flood at Cairo through the use of the facilities provided in the TVA Unified Plan as modified by the increase in project heights of the Gilbertsville Dam, would, on the basis of certain past floods have been from two to two and a half feet, a fair average reduction which could be expected from those facilities would be from zero to 1½ feet, or an average of about three-quarters of one foot.

ing degrees of success upon the lower river; upon the assumption that during the low stages on the river the projects set out in the TVA Unified Plan should come through the regulation of flow of waters in the Tennessee, contribute an increased discharge of 15,000 cubic feet a second six per cent of the time, the increase in low water flow would afford little benefit to navigation on the Mississippi; that the addition of that amount of water would have no effect upon the amount of dredging required, and in the past the channel has been [fol. 1832] kept open at the minimum previously experienced stages; that in the opinion of the witness the Unified Plan is not a justified means for increasing the navigable capacity of the Mississippi since there is no need of increased flow, and there will be no measurable decrease in river work."

I am familiar with the structural characteristics of Norris Dam. As to how I became familiar with this dam, I examined the Unified Plan and the defendants' and complainants' exhibits relative to Norris Dam, and I visited the dam during the construction.

Assuming that the plan of operation is to fill Norris reservoir so that it would stand at elevation 955 on December 15th, and that filling would increase at a uniform rate with respect to the volume, reaching an elevation of 1005 on April 15th, and that after that date the filling might extend to the top of the spillway, I have an opinion on the primary function of Norris Dam under that plan of operation.

"Q. Will you state that opinion?

Mr. Fly: I object to that.

Judge Allen: Objection sustained.

Mr. S. D. L. Jackson: Exception. And if the witness were permitted to answer, he would state that upon the assumption given in the question he has reached the opinion that the primary function of Norris Dam under such assumed plan of operation would be the development of hydro-electric power; and in pursuance of other appropriate questions relating to the same subject, the witness would further state if permitted that some of the basic features upon which that opinion is based are that the Norris reservoir provides approximately 2,650,000 acre feet of storage to the top of the gates, that this is storage equal to 16 inches of run-off, that a reservoir constructed for flood control pur-

poses would provide approximately one half of this storage; the fact that a minimum storage elevation of 955 feet is planned indicates that something over one half million acre feet is never to be released from the reservoir, and it is apparent that the only purpose of that storage would be to provide a head for the generation of electric power.

[fol. 1833] A further consideration in such opinion that Norris is primarily a power reservoir is that during the summer months the amount of storage below the top of the gates provided for flood control purposes is equal to only approximately 3 inches of run-off, whereas three times as much is needed for assured flood control; that the reservoir has more than adequate capacity for flood control, but the principle of operation is such that inadequate capacity will be provided during certain seasons of the year; that is, that the reservoir does not provide firm flood control protection under the plan of operation; that the operating plan for the reservoir assumed has every appearance of being the most logical plan for the operation of a combination reservoir for power development at the site and storage for downstream power development.

And in answer to a succeeding question based on slightly different assumptions, but relating to the same subject, the witness if permitted to testify would state that upon the assumptions that instead of the plan of operation which he had previously assumed, the plan was to maintain the Norris pool elevation from January 1st to April 1st at elevation of 1010, and that in April the pool would be allowed to arrive at elevation 1020 as a summer storage level, the witness would be even more firmly of the opinion that the dam under that plan of operation would be operated primarily for the production of hydro-electric power.

If I may continue,—and in answer to further appropriate questions relating to this subject, the witness if permitted, would state that the purpose of providing dead storage below elevation 955 at Norris, and below elevation 1415 at Hiwassee is to provide minimum head for the generation of hydro-electric power.

That if Norris reservoir were to be operated as a flood control reservoir, the plan of operation should be such that it should never be used except for the temporary storage of flood waters, to be released as fast as channel conditions permitted; and that if Hiwassee Dam were to be operated to effect the results set forth on page 99 of the Unified Plan

Now, that is an opinion that is based upon, again, if your Honors please, these new facts, to which we did not have access and could not have had access, and even the board of directors of the Tennessee Valley Authority, apparently did not know it until December 20th, until long after our case had closed. I still have numerous other purposes.

Judge Martin: Brother Jackson, for my benefit, would you answer further on what you mean by your last statement, 'And to rebut certain facts?' Just what do you mean by that?

Mr. S. D. L. Jackson: Well, just this, if your Honors please. Their opinions were based on certain facts. Their opinions are predicated, and conclusions are drawn from facts. Now, we think certain of those facts are inaccurate, and we would like to show what are the true facts on which such an opinion might be predicated, and also show where the divergence of opinion would then result from the different basis of facts on which it was predicated.

Judge Allen: You are saying that you didn't know what height, for instance, Gilbertsville was going to be, and that it added so many acre feet, as now calculated. I am asking you whether the changes that you say exist, and which take you unfairly by surprise, if there can be surprise in this case, relate only to the figures given for Gilbertsville.

[fol. 1823a] Mr. S. D. L. Jackson: No, no, that does not. Now, other capacities of other TVA projects have been changed, and the information has first come to us during the trial of this case. That also appears in Defendants' Exhibit 153. I mean they are now using or stating different figures as to the acre storage capacity or flood control possibilities on the Tennessee River throughout, as it affects and has relation to the Ohio Valley or to the Mississippi Valley. All of those things have shifted.

Judge Allen: And you claim that these changes are embodied only in this new report submitted to Congress?

Mr. S. D. L. Jackson: I am advised that these changes which relate not only to the physical structures that they proposed to erect, but also to certain changes in their proposed method of operation, first came to our attention when the witness Bowman was on the stand. That is, there had been no announcement, no information available, that gave us the proposed method of operation that the defendants now undertake to say they are going to follow, until the

witness Bowman took the stand as a part of their case.

Judge Martin: Your contention is, among other things, that you made your proof on the hypothesis of a certain situation with respect to Gilbertsville, offered your expert testimony on that hypothesis, and that something new developed after you had rested your case in chief, which would take you unfairly by surprise unless you prepared to meet it now, is that what it boils down to?

Mr. S. D. L. Jackson: Yes, I think that very fairly reflects it, if your Honor please, except that it is not limited solely to Gilbertsville, because there are some changes, not as great in degree as they are in Gilbertsville to the other structures, and changes in method of operation.

Mr. Fly: May it please the Court, there should not be any misunderstanding here. The only project where these gentlemen did not have the full information as to the physical structure of the dam is at Gilbertsville. All there is regarding these dams that these gentlemen may not have known all of this time is an added five feet of height at Gilbertsville Dam. To insinuate here that all of these structures have been changed is really to make a baseless charge. There is not a slight bit of evidence here to support any such suggestion.

I think we ought to evaluate this for what it is worth. Here is a man that spent years on the levee system. He is not coming in here to talk about the change in Gilbertsville Dam and what will happen at Gilbertsville, and he is not to talk about what will happen with a method of operation at Norris. He is not going to stop his testimony at the mouth of the Tennessee River.

They have seen their hydraulics case fall down about their ears, and now they have brought up another man from the alluvial valley of Mississippi who has spent a number of [fol. 1823b] years on the levee system, and we are going to have the whole blooming business over again.

Mr. S. D. L. Jackson: I might state further, if the Court please, that we were completely in the dark, and submit through no fault of ours; we tried to get records, we were completely in the dark as to the method of operation that the defendants propose to follow until Mr. Kimball and Mr. Woodward, two other of the defendants' witnesses took the stand, and until Mr. Kimball introduced an exhibit, I believe, Defendants' Exhibit No. 90.

Judge Allen: Which you objected to.

Mr. S. D. L. Jackson: Oh, vigorously.

But my point is that through no lack of diligence or lack of desire to present this case to the Court in the first instance, just up to the minute, we have had, since the defendants' case started, and after our case in chief closed, we have had certain material factors which we could not have access to before brought out, and I think that it is proper for us to be permitted to meet that at this time, which is the first opportunity we have had to meet it.

Judge Allen: Mr. Jackson, do you intend to offer anything else through Mr. Knappen except these questions?

Mr. S. D. L. Jackson: These are not the questions, if the Court please, these are statements of the references to defendants' evidence that Mr. Knappen's testimony would relate to.

Judge Allen: Would relate to?

Mr. S. D. L. Jackson: Yes, and in a general way describe the purpose of putting him on the stand, but it is not the offer of proof that we would desire to spread on the record as to his testimony in the event it were excluded.

Judge Allen: Well, does your offer to prove state in effect anything more than this?

Mr. S. D. L. Jackson: Oh, yes, that relates back, mostly, to the defendants' testimony that this is designed to meet, the offer to prove.

Judge Allen: The defendants' testimony was offered to meet your testimony given in chief, wasn't it?

Mr. S. D. L. Jackson: The defendants' testimony, as we stated before the recess, invoked numerous additional facts, and in that connection, if the Court please, I stated that certain other main river reservoirs had been changed by recent plans, and if the Court will consider page 403 of Complainants' Exhibit 116, which is in evidence——

[fol. 1823c] Judge Allen: Will you show it to us?

Mr. S. D. L. Jackson: Yes, your Honor. On page 919 of Defendants' Exhibit 153, which was put in yesterday, the Court will notice under the column headed 'Controlled Storage', in one of the columns in the table, on each of these pages it appears that four of the main river reservoirs are now stated by the defendants to have a different, and I think in all cases a larger controlled storage capacity than is shown by the table on page 403 of Complainants' Exhibit 116, which was the last available information prior to the appearance of this table.

Mr. Fly. Mr. Jackson, you do not suggest that there has been any change in these structures, that is merely a matter of operation.

Mr. S. D. L. Jackson: I don't know—well, so far as that is concerned a lot of the structures have not been built, and one of them is now in process of being erected, I think that is Guntersville.

Mr. Fly: So far as operation is concerned, the complainants' own witnesses were asked a question by the Court numerous times; the effects that would come from these dams would depend on the manner in which you operated them, and you can operate them differently and get different results, and all the witnesses, including Mr. Kurtz and Mr. Kelly were questioned along those lines, and that any one of numerous means of operation being assumed lays a groundwork for an endless amount of rebuttal, bringing in a levee expert here, is beyond all question.

Mr. S. D. L. Jackson: Of course, the witness now offered is much more than a levee expert. If the Court will examine the statement of his qualifications and experience, the Court will readily ascertain that he is much more than a levee expert, that he is a well qualified engineer on structures of this kind, dams, and levees, and power dams and flood control projects, and he has designed a tremendous flood control project within a very recent time.

[fol. 1824] Judge Allen: All of the proffered testimony of the witness Knappen lies in the field of opinion evidence. These facts involved are brought in to form a basis of an opinion, and the Court, in light of the three and a half pages of the statement to be introduced in the record as to the purpose of producing the witness Knappen, decides that the testimony to be proffered by this witness is immaterial, as well as not constituting proper rebuttal. You may have your exception.

Mr. S. D. L. Jackson: May we have an exception, and may we mark the sheets which the Court has returned to us as Complainants' Exhibit? Or would the Court prefer to have that copied in the record, or be given an exhibit number? It can be done either way.

Judge Allen: Copied in the record.

Mr. S. D. L. Jackson: Through this witness we intend to adduce testimony to the effect:

(1) That the testimony of the witness Kimball (stenographic record p. 4332) as to his method of determining floods against which protection should be provided, is fallacious and insufficient.

(2) That contrary to the opinion expressed by the witness Clemens (stenographic record p. 3591), and the witness Okey (stenographic record p. 4558), the most effective protection to the alluvial valley in the reach below Cairo against a flood of 2,600,000 c.f.s. at Cairo, would be the raising of the levees from 2 to 5 feet, and the improvement of the channel by cut-offs and the use of floodways.

(3) That contrary to the testimony of the witness Clemens, (stenographic record pp. 3604, 3605, 3606) and the witness Okey (stenographic record pp. 4506-4508) the Unified Plan of the TVA could not be depended upon to effect a material crest stage reduction at Cairo in any great flood.

(4) That whereas the testimony of the witness Clemens (stenographic record pp. 4221-4222) indicate that a reduction in the crest of the flood at Cairo through the use of the facilities provided in the TVA Unified Plan, as modified by the increase, in project height of the Gilbertsville Dam, would, on the basis of certain past floods have been from 2 to 2½ feet, fair average reduction which could be expected from these facilities would be from 0 to 1½ feet, or an average of about ¾ feet.

(5) That contrary to the opinion of the witness Okey (stenographic record pp. 4506-4508) a reduction in flood crest at Cairo through the use of the facilities provided by the Unified Plan, including the modified Gilbertsville Dam, [fol. 1825] would persist throughout the whole Mississippi River below Cairo, such reduction in crest would become insignificant by the time the flood had reached the mouth of the Arkansas, and that hence Mr. Okey's calculations of the acreage which would be protected by reason of the reduction of the crest at Cairo must be discounted considerably.

(6) That contrary to the opinion of the witness Okey (stenographic record p. 4511) that the TVA Unified Plan would appreciably mitigate seepage in the Valley in a great flood, such would not be the case.

(7) That contrary to the opinion of the witness Okey, (stenographic record p. 4508) that the operation of the TVA

Unified Plan in a great flood, such as the flood of 1927, would materially reduce stages in the backwater areas below Cairo, such would not be the case.

(8) That contrary to the opinion of the witness Okey, (stenographic record pp. 4510-4511) that highwater maintenance costs on the Mississippi would be materially reduced through the operation of the Unified Plan, such would not be the case, after the completion of the modified Jadwin Plan, and that the Unified Plan would not eliminate the necessity for additional flood control measures at Cairo and below.

(9) That contrary to the general testimony of the witness Okey, to the effect that great economic flood control benefits to the Mississippi alluvial valley would accrue from the operation of the TVA Unified Plan, such plan would not be economically justified for the purpose.

(10) That contrary to the opinion of the witness Clemens, (stenographic record pp. 3591-3592) and of the witness Okey (stenographic record p. 4558), that it is not practicable to raise the levees to protect against predictable floods at Cairo and below, the physical conditions are such that the levees can be raised safely under proper design, as much as is necessary.

(11) That contrary to the opinion of the witness Barker, (stenographic record pp. 4651-4653), that Norris and Hiwassee dams will provide a material benefit to navigation on the Mississippi River, they will not do so and furthermore there is no need for the increased flow in the lower Mississippi River.

(12) That the plan of operation of the Norris Reservoir, as proposed in the testimony of the witness Kimball, (stenographic record pp. 4278 and 4381 and Defendants' Exhibit 90), as a plan of operation not reducing the effectiveness of that reservoir for flood control, would actually make the primary purpose of the reservoir the production of hydro-electric power, and would reduce its effectiveness as a flood control facility.

That the plan of operation to which the witness Bowman testified (stenographic record p. 3893) that is, maintaining normal pool level and maximum pool level for power stor-

age at elevation 1020, would reduce the effectiveness of Norris Dam as a flood control facility.

(13) The same line of testimony with respect to Hiwassee Dam.

(14) That the plan of operation of Norris Reservoir as set forth in Complainants' Exhibit 116, (testimony of Dr. Morgan before the House Appropriations Committee), would indicate that the primary purpose of the dam is the production of hydro-electric power.

(15) That contrary to the testimony of the witness Barker, (pp. 4652, 4654), and that of the witness Bowman, (p. 3893), and that of the witness Kimball, (p. 4322), (all page references to the stenographic record), the dead storage provided in Norris and Hiwassee reservoirs, and referred to in Complainants' Exhibits 912, 352 and 362, and in Defendants' Exhibit 90, is provided in those reservoirs for the purpose of creating head for the generation of hydro-electric power, and that a different plan of operation should be provided if Norris and Hiwassee are flood control reservoirs.

And, may we at this time move that all of the testimony offered by the defendants having to do with the Gilberts-ville Reservoir and its changes from former designs, its effect upon the flood control possibilities in the Tennessee Valley as changed and its effect upon the alluvial valley of the Mississippi and floods upon the Mississippi be stricken from the record as immaterial.

Judge Allen: The motion is overruled.

Mr. S. D. L. Jackson: May we have an exception.

Q. Mr. Knappen, have you formed any opinion as to the most feasible sites for facilities for protection of the alluvial valley in this reach against flood overflow?

Mr. Fly: Objection, as immaterial, and as improper rebuttal.

Judge Allen: The objection is sustained.

[fol. 1827] Mr. S. D. L. Jackson: Exception. And if the witness were permitted to answer he would state in response to this, and other appropriate questions that he is familiar with the flood control facilities that have been erected on the Mississippi River from Cairo to the mouth of the Ar-

kansas River and is of the opinion that the most effective protection in this reach of the river against a flood of 2,600,000 cubic feet a second at Cairo could be obtained by raising the levees to the necessary height, and by improving the channel through cut-offs, and by the utilization of the New Madrid floodway; that a reservoir control system primarily for Mississippi River flood protection would involve excessive costs, with respect to benefits, and the value of tributary reservoirs is too problematical to be relied upon on an economic basis for flood protection in this reach of the Mississippi River; that he is familiar with the Tennessee Valley Authority Unified Plan, Complainants' Exhibit 328 in this case; that he also is aware that the projected Gilbertsville dam is now being constructed to an elevation five feet higher than is outlined in the Unified Plan, and is of the opinion that the Unified Plan, as so modified, could not be depended upon to effect a reduction of the flood crest stages at Cairo in every great flood, because it would not be effective when the discharge from the Tennessee was very small or very large, and that he believes the fair average reduction in the crest at Cairo which might be effected by the Unified Plan as so modified in a great flood which required the operation of the New Madrid floodway would be from zero to $1\frac{1}{2}$ feet, or an average of $\frac{3}{4}$ of a foot, and that such a reduction of crest would not carry on down the river and would diminish until its effectiveness would be eliminated at the mouth of the Arkansas River.

Q. Are you familiar with seepage conditions in the Valley, and have you studied the phenomenon of seepage?

A. I have, and I am.

Q. In your opinion would the Unified Plan appreciably mitigate seepage in the Valley in a great flood?

A. It would not.

Judge Allen: Just a minute, Mr. Witness. Don't answer please until counsel has been given an opportunity to object.

Mr. Fly: I have no objection so long as it is particularly on the point of seepage, but when he starts broadening out into the conditions in the alluvial valley, and all that, I think we should stop it. As I recall it, the specific point of seepage was brought out for the first time in our case.

[fol. 1828] Mr. S. D. L. Jackson: Very well, if I can get in this evidence, I would be glad to do it. I am asking for an opinion, I do not desire to try to evade—

Mr. Fly: You are not objecting, are you?

Mr. S. D. L. Jackson: Not at all, but I want to explain to the Court that I asked that question in view of their ruling for the purpose of trying to make up a record.

Mr. Fly: Well, let's go.

Mr. S. D. L. Jackson: Let us wait until the Court instructs me if I may.

Judge Allen: It is indicated by the ruling of the Court that this entire subject, lying as it does in the field of opinion evidence, involving facts stated upon which some expert may base an opinion, we consider it all immaterial and improper rebuttal, and unless there is some material fact that you want to rebut, we consider it improper rebuttal, and the Court on its own motion objects to the question and strikes the answer out.

Mr. S. D. L. Jackson: I might state that I did not anticipate that the questions would be answered; I was trying to make up a record. I may have an exception to the Court's ruling?

Judge Allen: Yes.

Mr. S. D. L. Jackson: If the witness were permitted to answer, he would state that in his opinion the TVA Unified Plan would not mitigate seepage appreciably in great floods.

Q. Assuming the operation of the TVA Unified Plan in a great flood, such as the flood of 1937, with reservoir draw-down of the lower river reservoir as the flood approaches, and release of storage after the crest at Cairo, what would be the effect on stages in the backwater area below Cairo?

Mr. Fly: Objection.

Judge Allen: Objection sustained.

Mr. S. D. L. Jackson: Please note an exception, and offer to prove by the witness, if permitted to answer, that in a great flood the operation of the Unified Plan, including draw-down of the lower river reservoirs as the flood approaches and the release of storage after the crest at Cairo would have only a negligible effect on the backwaters."

[fol. 1829] I am familiar with high water maintenance on the Mississippi and I have conducted a high water fight.

"Q. Based upon your experience, how much do you believe that the Unified Plan of the TVA would reduce high water maintenance cost on the Mississippi?

Mr. Fly: That is objected to as improper rebuttal.

Judge Allen: Objection sustained.

Mr. S. D. L. Jackson: May we have an exception, and offer to prove that if the witness were permitted to answer he would state that the Unified Plan would offer no appreciable amount of reduction of high water maintenance cost after the completion of the modified Jadwin plan; and, in answer to further appropriate questions relating to the same subject, he would state, if permitted to answer, that in his opinion the construction of the Unified Plan is unnecessary for flood control at Cairo and below and would not eliminate the necessity for additional flood control measures at Cairo and below, and that he is of the opinion that the flood control features at Cairo and below, and that in his opinion the flood control features of the Unified Plan are not justified economically for flood control on the Mississippi and an equivalent flood control protection can be provided more economically by other means. Levee protection equivalent to the features of safety provided by the Unified Plan can be obtained for \$9,000,000.

Q. Are the physical conditions, including foundation conditions, at Cairo and below Cairo along the Mississippi, such as would render feasible the raising the height of the levees?

Mr. Fly: We object to that question on the ground that, as I anticipate the answer, it is in direct rebuttal, not of our own witnesses, but of the complainants' own witnesses on the case in chief. Mr. Kelly testified on this subject, and read from a report of the Chief of Engineers to the effect that the levees had reached the limit of their practicable height, and was asked whether he agreed with it, and he stated that he did, and this testimony is clearly going back to the testimony in chief, and not rebutting any of the defendants' testimony, but testimony of their own witnesses.

Mr. S. D. L. Jackson: Mr. Okey testified—

Mr. Fly: Of course, we answered your testimony.

Judge Allen: Can't you have that checked by the record?
[fol. 1830] Mr. S. D. L. Jackson: I will be very glad to

have that record checked. I recall that they read out of some book to him, but I do not recall what, and I do want to call the Court's attention——

Mr. Fly: Page 2585 of the (stenographic) record.

Mr. S. D. L. Jackson: I call attention to Mr. Okey's testimony at page 4558, and Clemens at page 3595 and 3592 (of the stenographic record).

Judge Allen: At page 2585 of the (stenographic) record, Colonel Kelly was asked, 'The present levees on the Mississippi are about as high as it is desirable to construct them. An increase in the height accentuates the danger of a crevice, and its consequences, besides presenting the serious hazard of subsidence in the soft ground which they must occasionally cross.' Then he is asked whether he agrees with that statement of the Chief of Engineers and he says he has no reason not to agree with it.

Mr. S. D. L. Jackson: Of course, if that is the only theory relied on, that does not touch this question. It says the present levels are about as high as it is desirable to construct them.

Mr. Fly: Then it states the reasons, which shows what they have in mind when they say it is not feasible.

Mr. S. D. L. Jackson: The statement is that it accentuates the danger of a crevasse. As I understand it, that would be merely a sort of expression of judgment, and would not be an engineering determination of the physical possibility of raising the levee a moderate height.

Judge Allen: Objection sustained. Mr. Jackson, the Court considers this matter rather serious. Wouldn't it be a conservative estimate to say that 75 per cent of the testimony in this record is expert testimony?

Mr. S. D. L. Jackson: I would hate to try to give a percentage, I would say it is a considerable amount.

Judge Allen: For the record, to permit the introduction of such a large volume of expert testimony on behalf of the complainants, which then the defendants would rebut with their experts, and then to go over the same ground with the same experts, or as in this case a totally new expert, re-opens the whole controversy when the case has been tried; and also the proposition that in the ordinary course of engineering activity, in the ordinary course of carrying out the instructions of Congress under a statute which has not been declared by the Supreme Court to be null and void, the proposition that some change in plans entitles complainants

to such a re-opening of the case would mean that after the defendants' case is all in, then the complainants can try the case all over again having heard the defendants' proof. The Court bears all of these matters in mind and considers it improper rebuttal and the objection is sustained.

[fol. 1831] Mr. S. D. L. Jackson: May we have an exception, and state that if the witness were permitted to answer the question he would state that the physical conditions at and below Cairo on the Mississippi are such as would render it feasible to raise the height of the levees. The witness at one time entertained the idea that it was not feasible to raise the levee system, but since that time as a result of extensive research and practical experience, has learned that it is entirely feasible to raise the levee system all that is necessary. The problem of seepage and the problem of soft foundations he has learned can be solved by proper design.

That the experience of the witness is in part based upon the fact that he has recently completed the construction of an earth dam 125 feet high upon some 200 feet of pervious sand and gravel foundations without cut-off, and that last year this dam had some 60 feet of water stored behind it without any signs of distress."

I am familiar with the major problems involved in the maintenance of a navigable channel on the Mississippi below Cairo.

Q. Will you describe as briefly as you can those major problems?

Mr. Fly: Objection, as immaterial and improper rebuttal.

Judge Allen: Objection sustained.

Mr. S. D. L. Jackson: May we have an exception? And if the witness were permitted to answer, he would testify that he is familiar with the major problems involved in the maintenance of a navigable channel on the Mississippi River below Cairo, including minimum flow conditions, are the formation of crossings or bars, and the methods of excavating channels through them by dredging; that dredging may be necessary when as much as 250,000 cubic feet a second is flowing in the river, and dredging is continued to extreme low stages, which may have a minimum flow of around 100,000 cubic feet a second; that in order to help maintain the channel and induce the natural current to scour out the bars, a system of contraction works has been provided with vary-

to the effect that Hiwassee has sufficient storage capacity to completely control flood waters from above, it should be operated so the water would never be stored except the temporary storage of flood waters, to be released as rapidly as channel conditions below permitted.

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Q. Mr. Knappen, in your engineering practice in the flood control field, how do you go about determining the size and times of occurrence of floods, for protection against which a project shall be designed?

[fol. 1834] Mr. Fly: Objection. That is improper rebuttal, gone over on the main case, this whole matter of flood control, Mr. Kurtz and Colonel Kelly went over the same field.

Mr. S. D. L. Jackson: This question, of course, is merely preliminary.

Judge Allen: It is preliminary but it involves a lot of time. It is the same blind alley. Is it designed to lead up to an opinion?

Mr. Fly: I think the question is an opinion itself, calls for an opinion itself, your Honor.

Mr. S. D. L. Jackson: No, it is—that is, I don't want to mislead the Court.

Judge Allen: Is this a description of the factors which underlie an opinion.

Mr. S. D. L. Jackson: No, I don't believe it is. It is more a recital of an instance in his experience, of fact, which does enter into and have a direct bearing. If I might state what I would expect to develop by this in a few succeeding questions here, it would be that it is impossible to count upon seasonal storms, and in designing a flood control project you must take into consideration that the storms might come at any season of the year, that in the construction of the Muskingum flood control project—

Judge Allen: That is your opinion, isn't it, Mr. Knappen?

The Witness: I was going to state an actual occurrence of a summer flood.

Mr. Fly: That would be objectionable upon other grounds.

Mr. S. D. L. Jackson: It is based upon his experience.

The Witness: That is the background for my opinion.

Judge Allen: Yes. The objection is sustained.

Mr. S. D. L. Jackson: May we have an exception? If the witness were permitted to answer that question and other appropriate questions relating to the development of this same subject, he would state that in his engineering practice, in the flood control field, in determining the size and times of occurrence of floods against which projects are to be designed, the witness gives consideration to storms which have occurred in the climatological region; upon the basis of floods following these storms, it is common practice to develop project floods as a basis for design; that in all cases [fol. 1835] in the witness' experience the project storm is greater in magnitude than any previous occurrences of record; that in engineering practice it is assumed usually that the project flood may occur at any season of the year, and that in the opinion of the witness it is correct to make such an assumption, and that opinion is supported by the witness' experience in particular upon the Muskingum project, where during the period of construction a storm of great magnitude occurred about the middle of August, and that that storm was the third greatest storm that had ever occurred on the river in the period of record; that the witness had examined the records in the Muskingum Valley over a period of 80 years, and during that period there was no record of a similar occurrence during the summer months, and that in the opinion of the witness a period of record of 80 years is not convincing proof that a greater storm might not be experienced during any month of the year. I believe that is all.

Now, in connection with the testimony on seepage, in view of the fact that the defendants first injected that element into the case, and the ruling of the Court not permitting us to at this time go into the question, complainants now respectfully move that all of the testimony of the defendants relating to that subject and its effect upon the flood control problems in the Mississippi Valley be stricken from the record.

Judge Allen: The motion is overruled and the Court might indicate this, the Court will come to the time when it will rule very closely and very definitely with respect to what are the material issues in this case. The Court does not intend now, in the course of a lawsuit, immaterial evidence having been offered on the part of the complainants, and the defendants having been allowed to answer that with immaterial evidence, to sift out the defendants' immaterial

evidence, and leave the complainants' immaterial evidence in; and neither do we intend to stop now at this point and go through all of the record. We are going to go ahead and finish the case, and then there will be a sifting.

Mr. S. D. L. Jackson: May I have an exception? I take it this motion is overruled.

Judge Allen: The motion is overruled.

Mr. S. D. L. Jackson: Then, may I have an exception?

Judge Allen: You may have an exception. The Court will supplement its statement in this way: The sifting will take place in the finding of facts."

(The witness was excused.)

[fol. 1836] EDWARD J. MINSER was called as a witness on behalf of the complainants and, having been first duly sworn, was examined and testified as follows:

Direct examination:

I am 34 years of age and reside at Kansas City, Missouri, I am chief meteorologist for Transcontinental and Western Air Lines, Inc., which is an air line engaged in the transportation of mail, passengers and express between New York and Los Angeles and San Francisco. A meteorologist is one who engages in the science and study of weather and the effects of weather, as to rains, snow, sleet and the causes and results of certain meteorological phenomena.

I received my grammar and high school education in Minnesota and enlisted in the United States Navy in 1925, and was assigned to the U. S. Destroyer "Wood" in the battle fleet. In April 1927 I was transferred to the aerological school of the navy at Washington, D. C., which is the naval school for training meteorologists for forecasting weather, as far as weather affects the fleet. Upon completion of the course of instruction, I was assigned to the observatory at that station and subsequently acted as assistant instructor in the Navy Aerological School. While so engaged, as a matter of regular routine, I made airplane soundings of the upper air and became familiar with the making of such soundings and with the working up at an altitude of 17,000 feet, and the characterization and interpretation of the records of such flights.

Upon my discharge from the Navy in 1929, I entered the U. S. Weather Bureau Service at Allendale, North Dakota, [fol. 1837] where a kite station was maintained for sounding the upper atmosphere. I resigned from that position in May 1929, and became meteorologist for Transcontinental Air Transport at Albuquerque, New Mexico. I was stationed at Albuquerque and Clovis, New Mexico, Amarillo, Texas and Kansas City, Missouri, as meteorologist, performing all of the routine duties required of an airway meteorologist, which included surface and upper air observations, the collection and dissemination of air information, the drawing of weather maps, the making of forecasts for pilots and for operations personnel. In December 1931, I resigned from the air line and established a forecasting service at St. Paul, Minnesota. In June 1932, I returned to the air line service at the request of the company, which is now Transcontinental and Western Air Lines, Inc., and in September 1934, I was appointed Chief Meteorologist, the position which I now hold.

The particular work to which I have given my attention has been in weather forecasting. In air line work a forecast is all important as a requirement for safe flight operations. The system established with the air lines is to utilize all of the material of the Weather Bureau, or from other sources, and from this material to issue forecasts for the information of flight personnel. The air lines have a small forecasting station and are, therefore, able to utilize and adopt all of the latest and most modern ideas and methods that are approved for weather forecasting.

In the last nine years I have studied, analyzed and observed the history and behavior of all storms that have occurred in the northern half of the western hemisphere. In the meteorological office of the air line at Kansas City under my supervision, there are drawn daily four weather maps [fol. 1838] which cover the United States, and in addition the morning and evening maps cover the hemisphere from Honolulu to Bermuda and from the Arctic Circle to the Gulf of Mexico. I have made original studies in the icing of aircraft and have had a paper on this subject published in the Air Commerce Journal and in the Aeronautique Internationale. I have collaborated in the studies of dust storms, thunder storms and floods, and have contributed a section on meteorology for a textbook to be published shortly on the subject of aeronautical navigation. I keep in

touch with the various schools engaged in research on meteorology, and I maintain personal contact with the majority of the leading meteorologists in the United States and in foreign countries.

I have presented two papers before the American Meteorological Society, one being an analysis of excess rainfall in the United States and another entitled "Synoptic Studies of Icing Conditions in Free Air". My present activities include the supervision of the Transcontinental and Western Air Lines' forecasting staff composed of 12 meteorologists and five junior meteorologists. In my activities I have become familiar with the method of forecasting known as "air mass analysis", or the polar front method, introduced in this country by the United States Navy. I have analyzed and tested this method and it is employed under my supervision by the forecasters on my staff. This system is not generally used by the city weather bureau offices yet, but it is gradually being extended throughout the air weather forecasting services and has been in use on our air line for four years and has gradually increased the accuracy of our forecasts and permits detailed estimations of the cause of storms causing weather. The air mass analysis method of forecasting takes into consideration that portions of the earth's surface have uniform properties and that if a body [fol. 1839] of air stagnates over a given region, it will slowly assume those properties. It involves the movements and collections of masses of air possessing properties which may be identified with one region or another. It involves consideration of the effect of moisture contained in those masses, as well as the velocities at which those masses may or may not travel. The employment of this method requires a knowledge of the vertical structure of the air which is obtained from surface reports and upper air soundings from airplanes and balloons. A paramount consideration in the prediction of rainfall in connection with this method is a knowledge of the conditions under which the areas in which water vapor may be condensed out by cooling of the air to below its dew point. I have collaborated with Mr. Gail Hathaway, principal engineer of the Missouri River Division, U. S. Engineers Corps, in making an extensive study of a large number of flood storms in the United States. The method used in this study was to select certain storms that had occurred in the general vicinity of the dam sites upon which Mr. Hathaway was engaged and to transpose those

storms over the region of immediate interest. My part in those studies was to analyze the meteorological data and to determine the structure and cause of the storm to see if it were meteorologically possible to transpose the storm over the desired region. I applied the air mass analysis method in these studies. Storms causing flood rains may be divided into two types, namely, tropical storms of the type of West Indian hurricanes, and extra-tropical cyclones.

"Judge Allen: Now, perhaps, it will save time if we ask what is the purpose of the testimony of this witness?

Mr. S. D. L. Jackson: The purpose, briefly stated—

Judge Allen: And whose testimony does this rebut?

Mr. S. D. L. Jackson: The testimony is designed to rebut the testimony of the witness Kimball.

[fol. 1840] Judge Allen: What page?

Mr. S. D. L. Jackson: Appearing at page 4184 of the (stenographic) record, that the flood season on the Tennessee is from December 15th to April 1st. It is also designed to rebut the testimony of the witness Sargent to the effect that floods start about the middle of December and run till about the first of April.

Judge Allen: What page of the (stenographic) transcript?

Mr. S. D. L. Jackson: That is page 3722; and the testimony of the witness Kimball relating to the method in which he proposed to operate these dams that he would raise the reservoir from elevation 1005 on April 15th. Now, if the Court please—

Judge Allen: What page?

Mr. S. D. L. Jackson: That, I believe, is page 4278 (of the stenographic record). That is the defendants, in general, the defendants introduced evidence that a seasonal flood might be expected on this river, and this testimony is designed to show that it cannot be limited seasonally.

Mr. Fly: May it please the Court, we went into this at considerable length with Mr. Kurtz, and he was on the case in chief, and Mr. Kurtz took a flood right at the tail end, a very large flood, right at the tail end of the flood season. We went over that in considerable detail with him, and also with Colonel Kelly, we went into this matter of the flood seasons on the Mississippi and Tennessee. And we also discussed with one or both of those witnesses the matter of the pop-ups, or the summer floods. That whole matter was

gone into at considerable length. That matter of seasonal filling in line with that was gone into with them. There is not a thing that is new here as distinguished from the main case.

Judge Allen: Can you ask that in one question, Mr. Jackson?

Mr. S. D. L. Jackson: I will try. Now, you mean one question to—

Judge Allen: To rebut the testimony of Mr. Kimball, which is rather general, in answer to the question, as to what the question is in general. The statement is the flood season on the Tennessee ranges from about the middle of December to the first of April.

Mr. Fly: May it please the Court I have found one reference to the testimony of Colonel Kelly in which he stated he agreed with the following: 'In order to determine the effect of reservoirs on the Mississippi flood flows'—that is at [fol. 1841] 2604 of the (stenographic) record, 'It is necessary to establish some rule for reservoir operations. Practically all large Mississippi floods have occurred during the ninety days from February 15th to May 15th.' There is other material there, but the Colonel stated he concurred with that, and I believe at other times, which I have not spotted just yet—Oh, here it is. Colonel Kelly says at 2606 'but the general season,'—referring to the Mississippi and Tennessee—'The general season is approximately the same, that is, they both are liable to flood during the first five months of the year.' Now, I could go on with that sort of thing at considerable length, and, somewhat, I think, with Colonel Kelly's testimony, and I am sure that is true with Mr. Kurtz, and take into account that it was his own point. It was gone into amply on the main case, and I think it is wholly unjustified in the matter of rebuttal.

Mr. Fitts: I would like to refer the Court to the testimony of the witness Kurtz, appearing on page 2064 of the (stenographic) transcript. This is just a part of it, but I happen to have it right here.

Mr. S. D. L. Jackson: If the Court please, this is designed to show, this testimony, that there is a great probability of a storm causing enough rainfall to create a flood, occurring at any time of the year, though the heavy rainfall season in general may be through certain particular months of the year. And of course, its relation is that on a flood control

project it cannot be definitely determined that a flood, out of season flood, will not occur, because the possibility and probability of such floods does actively exist, and this witness is—

Judge Allen: That was considered by some of the defendants' witnesses, as I remember. They spoke of summer floods.

Mr. Fly: Spoke of summer floods, I believe Mr. Kurtz. Mr. Kurtz said, 'During other times of the year, that is during the summer and during the late spring, when some of the great storms on this river occurred, the percentage of rainfall is very much less, so much less that you have to have a very much greater storm during these particular months to produce a flood of a given magnitude than you would have to have during the months from December to April.

Judge Allen: The objection is sustained.

Mr. S. D. L. Jackson: May we have an exception? I think, if your Honor please, all of that discussion was precipitated by your Honor's request of me to frame one question, [fol. 1842] if I could, to bring out the substance of this witness' testimony, which question I had not yet framed or asked. May I—it will be short, I assure your Honor,—may I go through and make my record here in a fashion in which I had anticipated might have to be done in the event the Court should exclude that testimony?

Judge Allen: The Court has sustained that objection on the ground, the same ground, that it is not proper rebuttal.

Q. During what months of the year are tropical cyclones most frequent?

Mr. Fly: Objection.

Judge Allen: Is that the basis for an opinion that you want him to express?

Mr. S. D. L. Jackson: A recital of history, and also opinion as to what might happen in the future.

Mr. Fly: This is simply a matter of flood seasons, it can't have any other effect.

Judge Martin: Do you want to get that in as a basis for an opinion?

Mr. S. D. L. Jackson: This is based upon a historical study.

Judge Martin: Yes, I am not asking that, I am asking whether the ultimate fact that you want to get in here based on historical studies is an opinion?

Mr. S. D. L. Jackson: Yes, I believe that it is. If I may briefly describe, the witness will, from his historical study, be able to testify as to the times of year at which storms of the character I have described in the question do strike this geographical area with which we are concerned, and then based upon that fact, I would expect to elicit an opinion from him that in the future similar storms of that character may be expected to strike this area.

Judge Allen: The objection to this line of questioning is sustained, on the same grounds as heretofore given.

Mr. S. D. L. Jackson: May we have an exception, and if the witness were permitted to answer this question, and subsequent appropriate questions relating to the same subject, he would state that tropical cyclones occur most frequently during July, August and September; that the path of the tropical cyclone will follow a warm moist surface or current of air and avoid regions of cold dry air; that generally tropical cyclones either go up the East Coast of North America or stagnate over the Southern States. When a [fol. 1843] cyclone stagnates it will continue to deposit water until its water content and the sources of its supply are exhausted; that in the past the witness has studied tropical cyclones that have caused floods, in and adjacent to the Tennessee Valley area.

Judge Allen: What witness of the defendants testified about tropical cyclones?

Mr. S. D. L. Jackson: Well, there was one witness, I recall, that put in an exhibit showing a lot of storms in North Carolina, wasn't that Mr. Kimball?

Judge Martin: I recall the one at Tupelo.

Mr. S. D. L. Jackson: If I may be permitted to answer your Honor's question, Mr. Minser, in his recitals of his experience and training which I have asked to be copied into the record, stated that tropical hurricanes causing flood rains might be divided into two types, namely, tropical storms of the type of West Indian hurricanes and extra-tropical cyclones. Now, that I think, will give an answer to your Honor's question, and my terminology in this question was based upon that preceding statement.

Judge Allen: I wondered whether Mr. Kimball or any of the witnesses for the defendants described a tropical cyclone?

Mr. S. D. L. Jackson: I don't think they called them any-

thing but storms, but Mr. Minser has applied that terminology.

Judge Allen: All right, you may continue.

Mr. S. D. L. Jackson: The witness would testify in that connection that the witness has analyzed the storms of July 7th to 9th, 1915 in Alabama; the storm of July 17th, 1916 in North Carolina; and the storm of September 25th to 27th, 1929, in Georgia, all of which gave record floods in those areas, and which caused some precipitation in the Tennessee Valley area.

And, in pursuance of questions—appropriate questions relating to the development of this same subject, the witness if permitted, would testify, would state that in his opinion if a tropical hurricane should move inland and, on reaching North Georgia or North Alabama found its path blocked by a cold air mass, it is quite possible that it would deposit its suspended moisture in the upper Tennessee Valley.

And, in answer to further questions developing the same subject matter, the witness if permitted, would state that if such a tropical cyclone should stagnate in northeast Alabama it is probable that the heaviest rain would fall over the headwaters of the Hiwassee, Little Tennessee and [fol. 1844] French Broad and Holston Rivers, since the mountain range that these rivers drain would contribute to the lifting of the warm moist air, and then induce heavy rainfall;

That the cyclonic circulation around the center of the storm, warm moist air, would be directed at the Tennessee Valley, and there also would be heavy precipitation on the western watershed, which includes the Emory and Clinch Rivers;

That records indicate that tropical storms usually dissipate within two or three days after stagnation, so, in the opinion of the witness such a storm probably would give heavy rain for three days, but such rain preceding a storm might begin 24 to 36 hours before the stagnation of the storm;

That in the witness' opinion such a storm can produce precipitation in an amount more than an average precipitation of 11 inches over an area of 20,000 square miles.

Judge Allen: In connection with that point, the storm has been with us from the very first. Considered as storms the testimony with reference to cyclones will be cumulative. Considered as cyclones, that is to say the cyclone being a

storm sui generis will appear here for the first time, and it is not proper to consider them in rebuttal.

Mr. S. D. L. Jackson: May we have an exception?

Judge Allen: Yes.

Judge Allen: Mr. Jackson, will you inform the Court now how many more experts you will put on in rebuttal?

Mr. S. D. L. Jackson: Two following Mr. Minser.

Judge Allen: And will you have other witnesses besides these?

Mr. S. D. L. Jackson: I have two, both of whom will be—I don't think their testimony will take very long.

Judge Allen: And when do you expect to conclude your case or your part of it?

Mr. S. D. L. Jackson: Oh, I would think, as nearly as I can anticipate, that a great part of the testimony, particularly of the two expert witnesses, will fall within the scope of the ruling that the Court has already made, and with those witnesses I might state with respect to one of them that I have the offers to prove and statements prepared so that I can go along and make the record with considerable celerity. With respect to the other one, I do not have it [fol. 1845] prepared as yet in that order, and would be glad to get it in that order tonight, so that it will not take much of the Court's time. I would think that possibly by tomorrow noon, or maybe sometime in the afternoon, we would be through with the evidence, insofar as I know. It might be that there will be one other witness, not an expert, that I know about, but so far as I know, I think there will be two. I am not exactly positive of that.

Judge Allen: The Court expects to have the argument concluded and the case in its hands on Saturday. We are working along as rapidly as possible in the presentation of this proof, and of course the amount of time it takes can at best be only an estimate, and the Court appreciates that.

Judge Martin: It occurs to me that with these other witnesses that you mentioned in response (to Judge Allen's question, if you would do so, we could save a world of time by avoiding the question and answer form, and just say that it falls within the scope of our ruling, and you can state what you expect to prove by your witnesses. That might save a vast amount of time as compared with the question and answer form, which is quite tedious in the way of detail, to have questions and answers of each witness here.

Mr. S. D. L. Jackson: I have attempted to hold this to a minimum to conform to the Court's wishes, and my only fear is that to depart entirely from the regular procedure of asking the witness a question and obtaining the ruling of the Court on that question, and on testimony relating to the same general subject, and then stating an offer to prove, my fear is in departing entirely from that course of procedure might not properly preserve the record which of course we are exceedingly anxious to preserve.

Judge Martin: We are as anxious as you are.

Mr. S. D. L. Jackson: As long as it appears in the record that a question was asked relating to a particular subject, I have tried earnestly to combine and consolidate to the very utmost, and I will endeavor to get through just as fast as I possibly can, but I do hesitate, if your Honor please, to try to depart from that form of procedure entirely, because I do have the fear that it might waive, or not properly preserve some rights that we are exceedingly anxious to preserve. I do want to make my position clear, it is with no desire to impose upon the time of the Court, in trying to get through with this as fast as may be done.

At this time I would like to inquire if the Court has considered the application filed yesterday for subpoenæs duces tecum?

Judge Allen: The Court has not yet ruled on that; we will rule on it later.

[fol. 1846] Mr. S. D. L. Jackson: My only purpose in making that inquiry was to find out if the Court was ready at this time to make its ruling with respect to that, and the thought occurred to me at this time to ask the question as a result of some questions that the Court put just before recess. If we are drawing to the close of our testimony here, we would be eager to get the ruling at the earliest possible date that suits the convenience of the Court.

Judge Allen: The Court thinks it will have them the first thing in the morning.

Mr. S. D. L. Jackson: Very well, I appreciate your Honors' consideration."

I have studied flood storms that have occurred in the Southeast.

"Q. Will you state please whether or not from your studies you ascertained whether there was a seasonal variation in the types of storms causing these floods?

Mr. Fly: I object to that as irrelevant and improper rebuttal.

Judge Allen: Objection sustained. That, I take it, is an introductory question, Mr. Jackson?

Mr. S. D. L. Jackson: Yes, your Honor.

Judge Allen: The objection is sustained.

Mr. S. D. L. Jackson: May I have an exception, and I offer to prove that if the witness were permitted to answer he would state . . . that there is a seasonal variation in the type of storms causing these floods; that during the winter months from November through March, flood storms occurring in the southeastern states are extra-tropical cyclones; that during summer and early fall, July through October, flood rains in the South are generally caused by tropical cyclones that move across or stagnate in the southern states; that of course extra-tropical cyclones may occur during this summer season as well, but investigation shows that tropical cyclones predominate as the cause of floods during these seasons."

(The witness was excused.)

"Judge Allen: The Court understands, it is the understanding of the Court that when we suspend on Saturday there will be presented to us a comprehensive set of findings on both sides, and that if there is something that is wished to be substituted, opportunity will be given both [fol. 1847] litigants to do that on Monday morning.

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Mr. Fly: I assume all findings submitted to the Court will be submitted at the same time, and there will be a mutual exchange at that time.

Judge Allen: That is the understanding of the Court. The Court thinks that you should further understand that the arguments which will be held on Saturday will be the final arguments.

Mr. S. D. L. Jackson: What is the Court's plan? In the event this evidence does not take all day tomorrow, will it go into argument tomorrow, or on Saturday, or what?

If the Court please, if I may say, to intelligently digest

or analyze this evidence and to present it in any form that will be of any material assistance to the Court,—and that, as I understand it is the fundamental purpose of an argument, some time between the close of this evidence and the actual making of the argument in this Court is just essential in our opinion. It is just a superhuman task to get this material organized and any indulgence that the Court can give will be greatly appreciated by us.

Judge Martin: You mean that if the proof is concluded tomorrow, say, at the morning session, Mr. Jackson, that you would like to start the argument Saturday morning? Is that concretely what you mean?

Mr. S. D. L. Jackson: That is the idea I am trying to convey, if your Honor please, but I am still begging for more time than that. I appreciate the Court's ruling, that they want to finish this argument and everything by Saturday, but if we could get it over for a while, there is no doubt but that it will be of more material assistance to the court, and we honestly feel that it just makes counsel's efforts ineffectual to have the argument start within such a limited time.

Judge Allen: The Court will allow Saturday for argument. How much time will be left after rebuttal, of course, we don't know, tomorrow. But the Court will allow Saturday for argument, three hours will be allowed to each side.

Mr. S. D. L. Jackson: Well, in the absence of an opportunity to consult with my associates, I don't know what their opinions will be, but may I respectfully reserve an exception to the limiting of the time of argument to three hours, and to the holding of it so soon after the conclusion of the hearing of the evidence.

[fol. 1848] Judge Allen: You may reserve any exception to any phrase, comma, dotting of an 'i' or crossing of a 't', in anything that is announced in this manner by the Court. This Court bears this in mind, we are not a reviewing court. We are a trial court. We have heard this testimony. We have met here since November 15th. In addition, we not only have received, but we have read numerous briefs on each side. The ordinary case in the United States Circuit Court of Appeals involving a matter of this magnitude would be allowed two hours for each litigant. Now, the statement of facts in many particulars does not need to be made because we have heard the facts, while the review-

ing court has not heard the facts. This being the case, the Court feels that far from interfering with a substantial right of Complainants in allowing them three hours, in a trial court, where a reviewing court would allow them two, we feel that we are being very liberal indeed.

Also, we have tried to notify you of all of these things long in advance. It was as I remember it, very early in December, at least very early in the case, perhaps I should say substantially early, that we asked that the findings of fact state the number of the exhibit and the pages of the testimony referred to. We gave notice of that, and gave repeated notice of that. We have repeatedly given notice in order that counsel on each side might be prepared. We have given notice of our intentions to proceed with argument, and chief counsel for complainants has not conducted the rebuttal.

Judge Allen: The extreme liberality which has been accorded complainants and defendants in the preparation of their case is, in our judgment, now afforded in the presentation of arguments, which certainly need not deal very greatly with facts before three judges who have heard, with the exception of opinion, have heard nothing but facts since November 15th. Of course, we have heard some discussion of law, and that helps too. We have heard about the cases. Counsel were also notified to submit their final briefs at the conclusion of the evidence, and we expect that to be done.

Mr. S. D. L. Jackson: At the conclusion of the evidence or the argument?

Judge Allen: At the conclusion of the arguments, on Saturday.

Mr. S. D. L. Jackson: May we possibly ask the same indulgence there as about the findings that we may get it to the Court on Monday morning.

[fol. 1849] Judge Allen: Well, get your brief in and make your request on Saturday. The Court again calls the attention of the litigants to the fact that there is very little surprise in the facts of the case, and in view of the various decisions in all the courts, including two decisions of the Supreme Court, dealing with important phases of this question, there cannot be very much surprise in the argument. You cannot be very much surprised, for instance, by what

the Authority says, and the Authority cannot be very much surprised by what you say.

Mr. S. D. L. Jackson: May I have an exception to the ruling of the Court in these limitations of time and the short space of time which is permitted to intervene between the close of the evidence and the other proceedings?

Judge Allen: Yes, you may have."

[fol. 1850] JOEL D. JUSTIN was called as a witness on behalf of the complainants and, having been first duly sworn, was examined and testified as follows:

Direct examination:

I am 56 years of age, reside in Marion, Pennsylvania, and am a consulting engineer. I received my technical education at Cornell University from which I graduated in 1906 with the degree of Civil Engineer.

After graduation I worked on the Pennsylvania Railroad tunnels and the Hudson Company's terminal in New York City as inspector. From 1907 to 1912, I worked on the Ashoken Reservoir of New York City, making preliminary investigations and hydraulic studies for construction, and I was assistant engineer and resident engineer on the construction of the Olive Bridge Dam, a 200 feet high concrete dam. From 1912 to 1914, I was principal engineer for the Board of Public Works, Harrisburg, Pennsylvania, in charge of miscellaneous public work including a low dam across the Susquehanna River. From 1914 to 1916, I was resident engineer for the Fargo Engineering Company, doing preliminary investigation and construction work on a hydroelectric project in Wisconsin. The major project was the Wisotta Dam of 50,000 H.P. on the Chippewa River. I also worked on the dam at Cornell, Wisconsin, and did preliminary work on dams at Chippewa Falls and Holcomb Jim Falls. For a period of about six months in 1916 and 1917, I was resident engineer at Cumberland, Maryland, on the construction of water supply and sewerage work, involving a small dam and filtration plant. From 1917 to 1919, I was a construction engineer with the Aluminum Company of America, working on hydroelectric projects on the Yadkin River, N. C.

[fol. 1851] From 1919 to 1923, I was chief engineer with Ludlo Engineers, Winston-Salem, North Carolina, doing miscellaneous work in water supply, sewerage and water power throughout the southeastern states on individual jobs of rather small magnitude. In 1923 for about three months, I was construction superintendent on the reconstruction work of the Holtwood hydroelectric development project on the Susquehanna River. From 1924 to 1925, I was hydraulic engineer with the Power Corporation of New York at Watertown, New York. There was at that time great activity in hydroelectric work and my principal function was the planning of proposed developments and the determination of their economic feasibility under the direction of W. P. Creager, Chief Engineer. There were several such projects constructed.

In 1925 I was consulting engineer on Kanan Taishu and Taiwan Electric Power Company, which were two projects totaling about 30 million dollars on the island of Formosa, Japan. One project involved an earth dam about 160 feet high, 4000 feet long, and the other involved several earth and concrete dams and a power plant of about 100,000 H.P. capacity. From 1925 to 1928, I was hydraulic engineer for the U. G. I. Contracting Company of Philadelphia, doing investigation, design and construction of hydro-electric projects for companies in which the United Gas Improvement Company was interested. From 1928 to 1932, I was hydroelectric engineer with the United Gas Improvement Company of Philadelphia in general supervision for the parent company over companies in which U. G. I. was interested, and I also did some outside consulting work on dams and power problems, one of which consisted of an extensive investigation of the power possibilities of the Little Tennessee River.

From 1932 to date, I have been a consulting engineer in Philadelphia. My principal work has been on power problems and on dams for power, irrigation and flood control. During this period I am, or have been, connected as consulting engineer with projects involving approximately 40 dams, of which approximately 18 are under construction and the remainder are in various stages of preliminary investigation and design. These dams are located in Maine, New Hampshire, Vermont, Massachusetts, West Virginia, Nebraska, Mississippi, Ohio, Texas, New Mexico and Colombia, South America.

Purely flood control projects on which I am a consultant are Muskingum flood control project, Ohio, Connecticut flood control project in New Hampshire, Vermont and Massachusetts, Merrimac flood control project, New Hampshire, and Yazoo River flood control project, Mississippi. Other flood control projects which also involve power or irrigation on which I am a consultant are the New River project, West Virginia, Possum Kingdom Dam, Texas, which has recently been taken from the Army Engineers and I am no longer connected with it, Conchas Dam, South Canadian River, New Mexico, Denison Dam, on the Red River in Texas and Oklahoma.

I am a member of the American Society of Civil Engineers, a co-author of Creager and Justin's "Hydroelectric Handbook", author of "Earth Dam Projects" and co-author of "Power Supply Economics" by Justin and Mer-yine, which were all published by John Wiley & Sons, New York City. I was awarded the James Cross gold medal of the American Society of Civil Engineers in 1925 and the Fuertes Graduate Gold Medal by Cornell University in 1932 or 1933.

I have read the report entitled "Unified Development of the Tennessee River", referred to in this case as the "TVA Unified Plan", which is Complainants' Exhibit 328.

"Q. I refer you to this exhibit 328 and read to you from the lower right hand part of page 16 this sentence. This is the TVA Unified Plan, if the Court please, filed with [fol. 1853] Congress March 31, 1936. I am quoting, reading from the lower right hand corner:

'Since Tennessee River records have been kept for only a limited period, estimates of probable future floods must take into account flood data relating to all river systems in this portion of the country as well as all the characteristics of the river system and of the Tennessee Valley.'

Now, in connection with the determination of flood control works, is it sound engineering practice to proceed as indicated above, and consider all floods which have occurred in this general territory?

Mr. Fly: Objection, not proper rebuttal.

A. it is.

Judge Allen: Just a moment.

Mr. S. D. L. Jackson: Just a moment, if you will withhold your answer until the Court has had an opportunity to rule.

Judge Allen: Mr. Jackson, you introduced this exhibit, this report?

Mr. S. D. L. Jackson: Complainants' Exhibit 328? Oh, I think it was put in this record as complainants' exhibit, but of course it was prepared by the defendants and we are not bound in our view by all of the statements that might be contained in that.

Mr. Fly: It was put in on your main case, though.

Mr. S. D. L. Jackson: Oh yes.

Judge Allen: Did you obtain opinions from Major Putnam or anyone else in your main case with reference to this point?

Mr. S. D. L. Jackson: Your Honor, I don't believe we did?

Mr. Fitts: Aren't you developing the matter of project flood, and how to calculate the greatest flood to be anticipated? That has all been testified to by Mr. Kurtz.

Mr. S. D. L. Jackson: This will go into the possibility of floods during the summer season in the Tennessee Valley, this particular line of questions that I am now seeking to ask. [fol. 1854] Judge Allen: The objection is sustained.

Mr. S. D. L. Jackson: May we have our exception. If the witness were permitted to answer, he would state that it was sound engineering practice to consider all such floods. And in response to other questions relating to the same general subject, or other appropriate questions, the witness, if permitted to answer, would state that many summer floods have occurred in rivers in this general territory, that some of them have been the maximum floods of record on their respective watersheds."

The table (offered and received in evidence as Complainants' Exhibit 941) covers floods which have occurred between April 15th and November 30th on rivers in and near the Tennessee River Basin during the period of stream flow records. The records are obtained from the U. S. Geological Survey and the U. S. Weather Bureau. It shows in the first column the names of the rivers, in the second column the names of the places at which the records which I obtained were made, and the third column is a reference

key. The second sheet shows where the original information came from and explains the legend.

Examination by the Court:

This covers all of the rivers which are in the general vicinity of the Tennessee River, including the Tennessee, Mississippi, Ohio, Cumberland, French Broad, and Little Tennessee.

Cross-examination:

Some of these are Atlantic Ocean rivers. They are in southeastern states.

Direct examination continued:

The stations at which my readings were obtained are the points where the gauges were located and are shown in column 2. Column 4 is the drainage area in square miles above [fol. 1855] the station at which the reading was taken, and column 5 is the flood stage which merely means that when a river reached that height they considered it to be in flood.

Cross-examination:

It refers to the height. I expect in almost all cases it is the same as the peak.

Examination by the Court:

That means that as far as the records show, the stage peak on the high flood is the highest point reached on the date shown in the last column. For instance, on the Mississippi the exhibit shows that the highest flood was 42.5 feet in July, 1884, at Cape Girardeau, Missouri. That means that it is the highest recorded stage of the Mississippi in history, as far as these studies I have made show at Cape Girardeau. But all of these floods are not the maximum floods of record. Where they are, that fact is noted right in the table. The one that you picked was the maximum flood of record at Cape Girardeau. Unless otherwise noted that would follow down the column.

Direct examination continued:

That is designated in the next column on this exhibit and in the column which is opposite the one reading "July 4

Flood of 1844 on the Mississippi" appears the word "Maximum", and that was the flow that the Court just questioned me about.

Where I give figures in the column marked "Height Flood Discharge, Cubic Feet Per Second" I refer to the measurement of flow on that date at that place as determined by the [fol. 1856] government agencies. It does not necessarily mean that they actually measured that flood. It might be from their gauge heights and gauging tables. The column marked "Discharge per Square Mile, Cubic Feet per Second" is obtained by dividing the total discharge given in the previous column by the drainage area in square miles which is given in column 4. The date appears in the last column.

The rivers' names on Complainants' Exhibit 941 which are tributaries of the Tennessee River are the Little Tennessee and the French Broad River. The New River is located in West Virginia and Virginia and runs north of the Tennessee watershed and then turns and runs in a south-westerly direction and flows into the Ohio River. The Kanawha River is in reality formed by the New River and several other rivers that come in and might be described as just the lower end of the New River. As shown on Complainants' Exhibit 941, the maximum flood of record occurred on the Kanawha River on September 14, 1878, and on the New River the maximum flood of record occurred July 16, 1916.

I have previously examined Defendants' Exhibit 54.

"Q. Will you assume the filling of the Gilbertsville Reservoir to normal pool level between the first and middle of May, and the filling of other main stream reservoirs to normal pool level between April 1st and the first of May, and I will ask you whether or not such a plan of operation would increase or reduce the effectiveness of these dams for flood control.

Mr. Fitts: That question is objected to.

Judge Allen: You are now about to give your opinion?

The Witness: It would necessarily be an opinion.

Judge Allen: Objection sustained.

Mr. S. D. L. Jackson: May we have an exception, and if the witness were permitted to answer he would testify that this plan of operation of main stream dams such that the main stream reservoir would be filled to the normal pool

[fol. 1857] level between the first and middle of May, and the filling of the other main stream reservoirs to the normal pool level between April 1st and the first of May, would reduce the effectiveness of these dams for flood control.

In answer to further appropriate questions relating to the same subject, the witness, if permitted to answer, would state that the reasons for his opinion are, in general, that if space reserved for flood control on any river anywhere in this country, at least, is deliberately filled with water by the middle of May or any other month, there is no flood control provided.

It is absolutely contrary to all sound principles of flood control to adopt any other practice than to keep space (or reservoir capacity), intended for flood control purposes, empty at all times except in times of flood. This is because although summer floods are rare on many water sheds, you may get them at any time.

That all flood control systems with which the witness has been connected provide for taking care of great floods at all times, both summer and winter."

I have examined Defendants' Exhibit 90.

"Q. Mr. Justice, I direct your attention to Defendants' Exhibit 90 to the diagram on the right end of that exhibit labeled 'Cove Creek Volume Curve, Kurtz,' and ask you what it means in the field of flood control engineering?

Mr. Fitts: We object to asking the witness on the stand what it means. What is the purpose of the question?

Mr. S. D. L. Jackson: I am asking him as a skilled expert witness what significance that curve has to one who knows flood control engineering.

Judge Allen: Now, is this a question preliminary to the expression of an opinion?

Mr. S. D. L. Jackson: Yes, your Honor.

Judge Allen: As long as it is preliminary to an opinion, the objection is sustained on the ground that it is preliminary to an expert opinion.

Mr. S. D. L. Jackson: May I have an exception?

[fol. 1858] Judge Allen: Yes. The Kurtz referred to undoubtedly refers to the same Mr. Kurtz who testified in this case?

Mr. S. D. L. Jackson: That is correct, yes, but this is a Defendants' Exhibit.

Judge Allen: That is what rebuts Mr. Kurtz.

Mr. S. D. L. Jackson: My reference was describing the caption of that exhibit. If the witness were permitted to answer he would state that that diagram is a simple volume curve.

Q. Mr. Justin, could a reservoir of 1,312,000 acre feet capacity indicated,—and operated in the manner indicated be used for effective flood control?

• Mr. Fitts: That question is objected to.

Judge Allen: Objection sustained.

Mr. S. D. L. Jackson: May we have an exception, and offer to prove that if the witness were permitted to answer this and other appropriate questions relating to the same or closely allied subject, he would state that this reservoir may be used for effective flood control perhaps up to the capacity of 1,312,000 acre feet indicated, providing it is normally kept empty, allowed to fill up only during floods and emptied as soon and as rapidly as possible thereafter as can be done without downstream damage.

Q. Now, Mr. Justin, I ask you to assume that the rate of filling of Norris Reservoir is such that on December 15 it would stand at elevation 955, and that the filling would increase it at a uniform rate with respect to the volume, reaching an elevation 1005 on April 15th, and that after that date the flood season would be over and the filling might extend to the top of the spillway if sufficient water were available.

Will you please examine the diagram at the left end of Defendants' Exhibit No. 90, labeled 'Norris Volume Curve', and tell me, on the assumption of the plan of filling which I have given you, what, in your opinion, that diagram means with reference to the operation of a flood control dam?

Mr. Fitts: We object to that question.

Judge Allen: Objection sustained.

Mr. S. D. L. Jackson: May we have an exception?

Judge Allen: You may.

[fol. 1859] Mr. S. D. L. Jackson: And if the witness were permitted to answer he would state in answer to this question, and to other appropriate questions relating to the same subject matter, that in his judgment the method of operation indicated for Norris Reservoir on Defendants' Exhibit No. 90, which I might state the assumptions in the question were based upon, is not in accordance with good engineering

practice for flood control purposes, because if you want to get the maximum amount of flood control benefit out of any reservoir, the reservoir should normally be kept empty and allowed to fill in time of flood, but the upper portion of the diagram at the left of Exhibit 90 indicates that it is the intention to continue the filling of the reservoir till at least May 1st. That, if this method of operating the reservoir is followed, there would be no flood control value in any of the storage below elevation 1020. Above elevation 1020 it is uncertain as to whether or not it is intended to fill the reservoir to a higher elevation. If it is assumed that the reservoir will never be allowed to fill above elevation 1020, there would be about 500,000 acre feet of flood control capacity available.

And the witness would further state in response to appropriate questions relating to this same general subject matter, that the capacity above the top of the gates of Norris Dam to elevation 1052, as indicated on Defendants' Exhibit 90, would not be flood control capacity, as the water is not controlled as it goes over the top of the spillway, but such uncontrolled capacity cannot be credited to flood control. Under some conditions it may ameliorate flood damages down stream. However, if the discharge from other tributaries is causing the main stream to run banks full, the spillway discharge from Norris could itself cause flood damage.

Q. Mr. Justin, I now hand you Complainants' Exhibit 362 and call your attention to the figures at the right of the exhibit. What, in your opinion, does that figure represent?

Mr. Fitts: We object to that question, may it please the Court, because it is not proper rebuttal.

Judge Allen: Is this in connection with another opinion?

Mr. S. D. L. Jackson: Yes, it is.

Judge Allen: The objection is sustained, and for the further reason that it is a Complainants' Exhibit, and it has been explained by the complainants. It is not proper rebuttal in other words.

[fol. 1860] Mr. S. D. L. Jackson: I understand the Court, I merely want to state that this is designed to bring in focus this Complainants' Exhibit as compared to the Defendants' Exhibit. May I have an exception?

Judge Martin: Do you mean that there is some possible omitted question on that exhibit that you want to supply for the record?

Mr. S. D. L. Jackson: No, there is not any omission on that exhibit, if your Honor please, it is merely to focus the Court's attention to this particular Complainants' Exhibit, and the particular Defendants' Exhibit which has been mentioned in the previous preceding question. May we have our exception?

Judge Allen: Yes.

Mr. S. D. L. Jackson: I offer to prove that if Mr. Justin were permitted to answer this question and other appropriate questions, he would state that he had examined Complainants' Exhibit 362, that he noticed that the figure on the right of the exhibit represents a purely flood control reservoir having a dependable capacity of 1,312,000 acre feet. The figure on the left of the exhibit indicates a dam and reservoir having a dependable flood control capacity of 497,000 acre feet, provided the water is never allowed to rise above elevation 1020 except in time of flood. The dead storage indicated in the blue area on the figure on the left side of Exhibit 362 is to create a head for the development of power at the dam. The pink area on this figure would not be dependable flood control storage unless, except in flood time, it were left at or below elevation 955. And that, pursuant to other proper questions directed to the same general subject, if the witness were permitted to testify, he would state that in his opinion, Norris Dam is a power dam with incidental flood control to the extent of 497,000 acre feet, and for the purpose of comparing the Norris Dam with the proposed Cove Creek Flood Control Dam, shown on the right side of Exhibit 362, that it would be much less effective for flood control as flood control storage is only 497,000 acre feet compared with 1,312,000 acre feet at Cove Creek."

I have examined Complainants' Exhibit Nos. 352 and 353 and Defendants' Exhibit 89.

"Q. Now, with respect to the flood control system set out on Exhibit 352, which was introduced by the witness Kurtz in this case, and is further described in Complainants' Exhibit 353, and as set forth in Defendants' Exhibit 89, I shall ask you to assume that during the emptying program for [fol. 1861] those nineteen reservoirs, the opening of the lowest reservoir of each of the principal tributary groups set out on Exhibit 352 would be maintained at a constant and fixed discharge, and that it would be such as to keep the dis-

charge below the reservoir and all the way down as nearly as possible at banks full stage, and that the upper reservoirs of each tributary would have their discharge varied within a considerable range so as to suit conditions obtaining for any particular flood, and I shall ask you whether or not under that program for emptying those reservoirs they would be operated successfully for flood control purposes?

Mr. Fitts: We object to that as not proper rebuttal.

Judge Allen: Objection sustained.

Mr. S. D. L. Jackson: Exception, and if the witness were permitted to answer this and other appropriate questions relating to the same subject, he would state that if you were to assume that during the emptying program for these nineteen reservoirs, the opening of the lowest reservoir of each of the principal tributary groups set out on Exhibit 352, would be maintained at a constant and fixed discharge, that it would be such as to keep the discharge below the reservoir and all the way down as nearly as possible at banks full stage, and that the upper reservoirs of each tributary would have their discharge vary within a considerable range, so as to suit conditions obtained for any particular flood, he would be of the opinion that they could be used successfully for flood control, but, in the judgment of the witness, they could be operated more successfully if, during the emptying program, the discharge from the lowest reservoir of each of these principal tributary groups could be varied within a considerable range to suit the conditions of any particular flood. However, the operation should vary with each particular flood and this would have no bearing on the general design of the project.

Q. Mr. Justin, I now read from Exhibit, Complainants' Exhibit 328, the lower left quarter of page 18, where the following appears:

'Since it is impossible to predict from which source the major part of any particular flood may come, it is desirable that adequate storage be provided on as many as possible of the tributaries.'

I ask you if, in accordance with your experience that is a good general principle to apply in the selection of sites for flood control purposes?

Mr. Fitts: Objected to as calling for an opinion.

Judge Allen: Objection sustained.

[fol. 1862] Mr. S. D. L. Jackson: Exception, and if the witness were permitted to answer this question, he would state that he had noticed the lower left quarter of page 18 of Complainants' Exhibit 328, which contains the language quoted in the question, and that in the witness' opinion, that statement embodies one of the first and most important principles which has guided the selection of flood control projects with which he has been connected.

Q. Mr. Justin, I ask you to refer again to Defendants' Exhibit No. 89, and to Complainants' Exhibits 352 and 353, and I now hand you Complainants' Exhibits 354 and 355, and ask you whether or not you have examined the two latter exhibits?

Judge Martin: Brother Jackson, does this lead up to an opinion on some fact?

Mr. S. D. L. Jackson: Yes, which will be brought out by my next question, but I feel that I should——

Judge Martin: I just wanted to know how closely we should follow you. In other words, if we are ruling it out, you are just making your record, and it is not necessary for the Court to give very close attention. If you are about to present some fact, we will follow it very closely.

Mr. S. D. L. Jackson: The only fact I expect to present at this place, is that he has examined the exhibits."

I have formed an opinion as to the comparative degrees of flood control which will be afforded by the so-called Kurtz system illustrated on Exhibit 352 and 353 on the one hand, and the system of reservoirs illustrated by Exhibits 354 and 355 of the TVA plan.

"By Mr. S. D. L. Jackson:

Q. Which of the two systems, in your opinion, will provide the greater degree of flood control?

Mr. Fitts: Objection.

Judge Allen: Objection sustained.

Mr. S. D. L. Jackson: May we have an exception, and if the witness were permitted to answer he would state that in his opinion the so-called Kurtz system will provide, by far, the greatest measure of flood control, that in forming this opinion, the witness assumed that for either system of reservoirs, the details of design and construction will be ex-

ected in accordance with good engineering practice. That under the Kurtz system there is ten times as much flood [fol. 1863] control storage as under the TVA plan. That the Kurtz system controls 78 per cent of the watershed above Chattanooga, whereas, the TVA plan controls only 25.7 per cent. That an analysis of the inches of flood control storage at the various reservoirs under the two plans indicates great superiority for the Kurtz system.

That a plan involving 19 reservoirs arranged on the tributary streams, will, in general, be more efficient than one involving only three on some of these tributaries even though the total storage might be equal instead of being ten times greater in the Kurtz system than in the TVA system. That the Kurtz system is superior in every respect to the TVA plan, except that the TVA reservoir scheme is vastly superior for the production of power.

That the witness has not studied the details of the two schemes, but has merely familiarized himself with the general features of both of them, and it is not necessary for him to know all the details, as he bases his opinion on his judgment and general experience in flood control work.

Q. I now refer you to Complainants' Exhibit No. 349, Mr. Justin. Now, assuming that the dams of the TVA Unified Plan were built in such a manner and to such height as to eliminate all flood damage below them, would that Exhibit 349 show the average annual flood benefits that would accrue due to the elimination of such flood damages?

Mr. Fitts: Objection.

Judge Allen: Objection sustained.

Mr. S. D. L. Jackson: Exception, and if the witness were permitted to answer this question and other appropriate questions relating to the same subject, he would state that he had examined and had referred to Complainants' Exhibit 349. That that exhibit does not show the average annual flood benefits that would accrue due to the elimination of all flood damages on the Tennessee River, because the Tennessee Valley Unified Plan provides no flood control benefits for a number of tributary streams on which damages have occurred. That, on the basis of Exhibit 349, if the Unified Plan completely eliminated all flood damage on the main river and on the tributaries where TVA dams are located, the average annual benefit would amount to \$828,-

588. And, in response to other appropriate questions directed to the same subject matter, the witness would state that on the basis of Complainants' Exhibit 115, page 279, the annual primary energy output of the system is estimated at 5,780,000,000 kilowatt hours, and the revenue therefrom is estimated at \$23,120,000 per annum. That the ratio of the annual power benefit so determined to the annual flood [fol. 1864] control benefits on the basis of Complainant's Exhibit 349 is 28 to 1. On this basis of computation, the Unified Plan would afford about 4% of the total benefits through flood control, and about 96% of benefits of power.

That the witness is familiar with many flood control and many power projects, and if, on any one of those projects, the average annual power benefits were 28 times the average annual flood control benefits, the witness would consider that the project was primarily a power project."

Cross-examination:

On Complainants' Exhibit 941 I only make three references to the Tennessee System, one on the French Broad, one on the Tennessee, then another on the Little Tennessee. I don't notice any other tributary streams of the Tennessee. I presume that McGhee, Tennessee, is on the Little Tennessee watershed. I have not been there. I would have to refer to a map of the TVA projects to tell whether any project authorized by TVA is above any place on this exhibit where I have recorded a flood stage. I don't have the map now. We had it a minute ago. I made up this exhibit without reference to the location of the TVA's projects. This is just a table of values. The map in Complainants' Exhibit 328 does not show the towns. It shows the proposed location of Fontana Dam, which is well up on the watershed, and I would say that McGhee is most certainly below that, because the watershed area on this exhibit is 2,470 square miles. I know where TVA's projects are in general.

As to the points I have listed here for the flood stages and whether there is any TVA project above either of those points, I would say that on the Little Tennessee River, most surely there were. I mean the proposed Fontana Dam. I don't think TVA has proposed any projects on the French Broad River at all. I have never seen a plan of the TVA that ever showed anything on the French Broad River. I [fol. 1865] have never seen any plan of TVA that showed any dam on the river system above Knoxville.

Some of these rivers are tributaries of the Ohio-Mississippi System and some flow into the Atlantic. I think we took the Tombigbee River out of the exhibit. The Coosa and the Black Warrior Rivers flow down into the Gulf section. There are more of these rivers in the eastern part of the territory, the other side of the mountain range, that flow into the Atlantic. They rise east and south on the other side of the mountain range. Between the Tennessee Valley and the valleys of these rivers there is a mountain range.

The flood stages which I have listed on this exhibit for the French Broad River and the Tennessee River look like they might be parts of the same flood. Whether or not the peak on the French Broad is reflected in the stage shown for the Tennessee, I cannot tell without looking at the hydrograph. As to whether the peak at Dandridge on the French Broad was two days prior to the peak at Knoxville on the Tennessee, I have them listed and I would have to answer I do not know whether that is a fact, whether it is the same flood. It may be and it may not be. I can tell by examining the hydrographs at the two places and tracing it down. I do know that the French Broad empties into the Tennessee above Knoxville and Dandridge is back up on the French Broad River. My figures on this exhibit list the flood at Knoxville two days subsequent to the flood stage at Dandridge. I do not show the duration of this flood crest, they are just peaks that were selected for the table. When the flood popped up we caught it at the peak and that is all we have put down on this exhibit. The other would be much more of a job. The records that I used show the peaks and that was the only thing at the moment I was interested in. I did not interest myself in the duration of the crest for the [fol. 1866] immediate purpose of preparing this table. The only purpose of preparing the table was to show that there were summer floods in this part of the country. The exhibit shows the maximum flood on the French Broad on May 21, 1901 and the flood on the Little Tennessee five years later, but I did not record any flood stages on any other tributary of the Tennessee around the time of the flood on the French Broad. There may have been some; I don't know. The probability is that each one of these storms had lesser storms on watersheds immediately surrounding where there may have been a very local storm. You can't always say that these are local storms that we are dealing with here.

The only way I can answer the question, whether there are any records which I examined, showing that these floods were general in character or were sustained in duration, correctly is to say that I examined the records to obtain this table, to get a table that showed a number of summer floods, and at that time I was not paying attention to anything else, and I did not study how sustained the floods were. I would have had to have gone over and picked out different watersheds, and plotted a lot of lines, and worked it out to show what it was, and how general it was.

My instructions were to make a table of summer floods that could be readily obtained in this general vicinity. As to whether they were the severest floods obtainable, I have in the table all of the maximums that we could get, whether or not you have them, I don't know. The records which I examined do not indicate what the flood stage was at Chattanooga for those same floods, but it is not a high flood. As to whether it was not a flood stage at Chattanooga, I think from reading the evidence, something like 30 feet is flood stage. I am sure that this flood was not recorded as producing a flood stage at Chattanooga, which is something [fol. 1867] like thirty feet at flood stage. I don't know that none of these floods recorded on this exhibit produced a flood stage at Chattanooga. If the records had shown a flood stage at Chattanooga at the time of these floods, we would have found it. I will grant that historically there have been no serious floods at Chattanooga in the summer time. The hydrograph records show that.

(The witness was excused.)

[fol. 1868] CLARENCE WATSON was recalled as a witness on behalf of the complainants and, having been previously sworn, was examined and testified further as follows:

Direct examination:

I am the same Mr. Watson who testified in this case before. I testified that I was the district manager of the Cumberland District of The Tennessee Electric Power Company and I have held that position since July, 1935. From 1929 to 1935, I was district manager of the Middle Tennessee District of The Tennessee Electric Power Company.

From 1920 to 1929 I was employed by a predecessor company, the Southern Cities Power Company, from 1920 to 1925 as superintendent of operations and from 1925 until the latter part of 1929 as general superintendent.

I am acquainted with Mr. R. D. Cowley who is a resident of Kelso, Tennessee, in the Middle Tennessee District. Mr. Cowley is the Secretary-Treasurer of the Lincoln County Electric Membership Corporation. Mr. Cowley is a banker at Kelso, Tennessee. Mr. Cowley testified in this case in a deposition taken by the Special Master and in which he referred to Mr. Tom Greer. Mr. Greer was connected for a few months with The Tennessee Electric Power Company after its purchase of the Southern Cities Power Company. He was in the Legal Department and engaged in making appraisals of the property. Otherwise he was not associated with The Tennessee Electric Power Company.

“Q. Do you know anything about an occasion of a request made by a group of residents of Kelso to Mr. Tom Greer for an extension of service?

A. Yes, Mr. Cowley and other interested parties from Kelso—

Judge Allen: Were you there?

The Witness: I was in the office and the matter was referred to me.

[fol. 1869] Q. Were you present at the conversation which you are now going to relate?

A. No, I was not present.

Mr. Fly: We object, of course, to any statements of what took place.

Judge Allen: Objection sustained.

Q. Was there any investigation made by you as superintendent for the Southern Cities Power Company of a request for service in the vicinity of Kelso?

Mr. Fitts: We object to that on the ground that it is irrelevant. Unless he is going to testify what he found out, it is irrelevant for him to answer the question.

Mr. Bemis: The witness has said that he reported—

Judge Allen: Unless you have asked this question as preliminary to a statement of what this man physically did and took part in, it is not relevant.

Mr. Bemis: Mr. Cowley undertook to show that frequent requests had been made for service which were ignored, and I was showing that that is not the fact.

Judge Allen: Well, ask this man whether requests were made and were ignored.

Judge Allen: Were there?

The Witness: No requests were made that were ignored.

Judge Allen: Is that all you want to prove?

Mr. Bemis: No, that is not all I want to prove by this witness, but perhaps that covers this particular extension.

Q. Now, Mr. Cowley also testified, 'I was trying to get current over there and tried to get Mr. Watson to consent to allow me to build my own line at my own cost by digging the holes and furnishing the poles, over which he would bring current up to my own home, which was approximately 2½ miles.' Will you state whether or not Mr. Cowley ever proposed to you, personally, that he would be willing to construct at his own expense a line extension so as to obtain service from the Tennessee Electric Power Company, or its predecessor, the Southern Cities Electric Power Company?

A. No, he did not.

Q. How much would such a line cost?

[fol. 1870] Judge Allen: The Court has indicated—and the Court will now say what it has not said before. As this case was going along, we were informed by Mr. Raymond T. Jackson, chief counsel for the complainants that a case was pending which he was supposed to argue in the Circuit Court of Appeals in the Fourth Circuit, on Thursday or Friday of this week, and Mr. Raymond Jackson asked this Court, in view of the fact that the Fourth Circuit had refused to postpone the argument, he told this Court that he wanted a breathing spell between this case and the hearing in the other case, and after consultation with the full bench, the presiding Judge of this Court conferred with Judge Parker on the telephone, explained the circumstances, and with the approval of the full Court, a letter was written to Judge Parker asking that the argument in the second case be deferred in order that Mr. Jackson might have a breathing spell between the conclusion of this case and the time when he had to argue the other case. From time to time the Court has mentioned to counsel that we bear in mind not only our statutory obligation to expedite this case,

the enormous interruptions of the work of the entire circuit, which occurs in this case, but that we were endeavoring to finish this case also for the benefit of counsel. That appears in the record, and that is the fact.

Mr. Bemis: Well, if the Court please, I am not inclined to disagree with the view of the Court—

Judge Allen: I am not stating a view, I am stating facts. We have tried to expedite this case bearing in mind the situation of Mr. Jackson also, and his very urgent request for a breathing spell between the conclusion of this case and the time that he had to argue the other case, and on the request of the Court he was given until next Thursday to argue that case. The Court has indicated what are the proper limits of rebuttal.

Mr. Bemis: May I recall to the Court that as a part of our case in chief we offered testimony taken by depositions of certain witnesses; that the defendants at the same time offered the testimony of certain other witnesses that we objected to on the ground that it was not the proper time for the defendants to offer testimony.

Judge Allen: And the Court ruled that those depositions by the defendants should be received as a part of the defendants' case and not as a part of the complainants' case and we understand that that instruction is followed in the record.

Mr. Bemis: That is correct, but under those circumstances there was no opportunity to make other than general objections to particular portions of the testimony taken, so we [fol. 1871] have never been advised as to the Court's views as to which parts of those depositions were competent and would be considered by the Court in reaching its decision.

Judge Allen: No opportunity was denied you to make objections at any time.

Mr. Bemis: Objections were made generally to the competency and materiality of them as a whole.

Judge Allen: No objection has been at any time denied counsel on either side unless an exception were granted and taken, and many times the Court has sustained an objection without it having been actually made.

Mr. Bemis: What I am trying to point out is that the testimony which we are seeking to rebut remains in the record without having been stricken out.

Judge Martin: The question was 'What it would cost to build that line.'

Judge Allen: The Court considers that any evidence bearing on that subject is incompetent, immaterial and irrelevant, and particularly improper in rebuttal.

Mr. Bemis: And may we have an exception?

Judge Allen: You may."

Any requests received by The Tennessee Electric Power Company during the period from 1933 to 1934 and the early part of 1935 for extension of service to residents in Kelso or in the vicinity of Flintville would come to my attention as District Manager if they were made. During that period no requests were made for extension of service by The Tennessee Electric Power Company to residents in Kelso or in the vicinity of Flintville. There was an application filed in 1932.

The document (offered in evidence as Complainants' Exhibit 937) is a petition signed by the prospective customers in Kelso and Flintville for electric service.

[fol. 1872] Examination by the Court:

It was for proposed service from us and not from TVA.

Cross-examination:

By prospective customers I do not mean people that I thought might be customers. They were people in Flintville and Kelso. They were not actually getting service at that time.

Direct examination continued:

Complainants' Exhibit 937 is a part of the office records of the Middle District of The Tennessee Electric Power Company. It has been in my possession or in the possession of the company continuously since the time it was presented. It was received prior to June, 1932. As District Manager pursuant to this request for service I authorized the Engineering Department to make a thorough investigation of this proposed line extension on behalf of the proposed customers mentioned in Complainants' Exhibit 937.

"Judge Allen: Isn't there testimony in this record repeatedly to the effect that the Tennessee Electric Power Company has served everyone that it is capable of serving in that territory?

Mr. Bemis: I think so, the testimony was offered by the

defendants to the contrary, and that is what we are trying to rebut.

Judge Allen: In other words, they rebutted your testimony, and now, you want to rebut theirs?

Mr. Bemis: Well, this is an incident that was offered as part of the defendants' case, to which we are offering contradicting evidence."

The document (offered in evidence as Complainants' Exhibit 938) is our office file covering the engineer's report on the investigation of the line extension into Flintville and Kelso. It is a copy of the engineer's report on his investigation. It is a report made to me as District Manager of Mid-[fol. 1873] dle Tennessee. It is an original record of The Tennessee Electric Power Company and has been in the possession of the District Office since it was presented to us some time in 1932.

"Q. What, if anything, was done subsequent to that report? Was notice given to whoever it was presented the original petition, that is, Complainants' Exhibit 937?

Mr. Fitts: We object to the question on the ground that it is immaterial and irrelevant, and to its form.

Judge Allen: Objection sustained.

Mr. Bemis: As to form, if the Court please.

Judge Allen: The objection is sustained on the ground that the subject of the inquiry as shown by this document is immaterial.

Mr. Bemis: And may we have an exception?

Judge Allen: You may.

Judge Allen: It might save time of counsel for the complainants, as well as counsel for the defendants, if in these matters they would where they can admit these documents came from the offices of the different managers instead of having that proved.

Mr. Fitts: We will admit that.

Mr. Bemis: In the light of the Court's ruling perhaps it would shorten it if I would state in the form of an offer to prove further testimony on this same subject matter. I understand the Court regards this particular line of testimony as incompetent and irrelevant.

Judge Allen: The Court has endeavored to make that clear.

Mr. Bemis: We reserve our exception and offer to show that pursuant to appropriate questions the witness would state that subsequent to the report of the engineer in regard to the feasibility of the line extensions to give service to Kelso, among other places, an investigation was made by the Railroad and Public Utilities Commission for the state of Tennessee, that Complainants' Exhibit 939, consisting of two sheets, and constituting a report by the Tennessee Commission, and by the engineer of the Tennessee Commission, which is offered as a part of this offer to prove was re-[fol. 1874] ceived, defined among other things that the proposed extension was not feasible, or not required under the regulations of the Commission, that subsequent to that time a further investigation of the possibility or feasibility of these proposed line extensions was made; that complainants' exhibit 940, consisting of a report by the district engineer to the witness with attached map of the proposed line extension is a part of the records of the company and was received by the witness sometime in November, 1932, that the results of this further investigation were made known to the applicants for service extensions.

Mr. Bemis: If the Court please, I believe I made no offer of complainants' exhibit No. 937 and 938, but I now make the offer so that the record can show the Court's ruling.

Mr. Fitts: We object separately to 937, 938, 939 and 940 on the grounds they are incompetent and immaterial, not proper rebuttal, and furthermore incompetent and hearsay.

Judge Allen: Aren't you offering all of these exhibits that we have before us?

Mr. Bemis: I had assumed from the Court's ruling that these further exhibits would fall within the Court's ruling, that what was done pursuant to these requests for service was not competent. If I am in error, I am sorry.

Judge Allen: You are offering these five exhibits?

Mr. Bemis: Yes, and to save time I had made the offer as part of an offer to prove.

Judge Allen: I see.

Mr. Fitts: There are four exhibits, I think. They are 937, 938, 939 and 940. We object separately to each of them on the grounds stated.

Judge Allen: The Court rejects all of these exhibits upon the ground that they are immaterial to the issues of the case, and not proper rebuttal.

Mr. Bemis: And we save an exception. And I presume that that ruling of the Court would be applicable to the testimony of the witness Cowley, which we are seeking here to rebut.

Judge Allen: There is no motion pending before us.

Mr. Bemis: If the Court please, then, we move to strike out the testimony of the witness Cowley and the witness Hutchinson (in the stenographic record) as follows: The entire deposition of R. D. Cowley at pages 25 to 72 inclusive [fol. 1875] of supplement A to December 7th, 1937; the entire deposition of the witness, K. T. Hutchinson at pages 81 to 82 inclusive of supplement A to December 7th, 1937; the following testimony of the witness E. W. Carmack on pages 12 and 13 of said supplement for which testimony the narrative statement herein is substituted:

'During the time I have been here, I have had the opportunity to become acquainted with rural electrification service in the rural areas of this section. Prior to the formation of the Middle Tennessee Electric Membership Corporation, there were considerable areas in this County that were not receiving electric service. Those were the same areas which are now being served by the Corporation. I am familiar in a general way with the location of the lines now operated by the Corporation. To the best of my opinion in talking to those people who now have service from our Corporation, those lines are located in territory that was not previously served by any power company. None of the members of the Corporation were served by The Tennessee Electric Power Company prior to the organization of the Corporation, according to my investigation.'

Mr. Fitts: That motion I think is clearly improper, because that goes to all of the testimony of the witness Cowley who testified to a great many other things besides this one particular isolated point.

Mr. Fly: I am inclined to agree that all of the testimony on this sort of a point will ultimately be determined to be irrelevant by this Court. But I don't think the Court can now——

Judge Allen: Now, don't assume what this Court is going to do.

Mr. Fly: I will assume to state my own opinion on it, your Honor, that it is irrelevant. I should not be surprised if

the Court would come to that conclusion as regards to some of the material that is submitted in our case. But I don't think that the Court can now go back and sift all of the evidence which in its final ruling will be deemed to be irrelevant.

Judge Allen: If counsel for defendants will state there is other material in the testimony of the witness Cowley that is here attempted to be rebutted and that is material and relevant—

Mr. Fitts: I think the testimony is as to the operation of his cooperative, and as to how it was organized, and whether or not it was organized by pressure from outside, or because of the desire of the people alone—

[fol. 1876] Judge Allen: It bears on the issue of coercion?

Mr. Fitts: That is correct, and of the relationship between the cooperative.

Judge Martin: Does counsel for the complainants agree with the statement of Mr. Fitts' as to the other testimony of the witness Cowley? If so, that would save the Court trouble of reading that deposition possibly.

Mr. Bemis: It is our view, and it was stated in our general objections—

Judge Martin: Not your view, but do you agree with his statement? He stated specifically that certain matters were testified to by the witness Cowley. Do counsel agree with his statement or not, now?

Mr. Bemis: I don't recall that he gave testimony as to how the Lincoln County Electric Membership Corporation was organized.

Judge Allen: The Court will ask you to check that matter and to report to the Court.

Mr. Bemis: Thank you.

Mr. Fitts: If that statement is questioned, I would like to get it settled right now.

Judge Allen: We will expect a positive report from you on that point before we rule upon this question. Now, let's proceed.

Q. Mr. Cowley stated in his testimony, in response to the following question: 'In these local meetings about which you have testified, and these mass meetings that met with the county agent Sloane, and manager Childress, were the rates of the TVA discussed', to which Mr. Cowley answered, 'Not so much as the fact that they could get elec-

tricity. They had trouble in getting it. I was interested in securing it for myself, but I cannot tell what other people thought, but I wanted it for myself. I wanted electricity and I wanted it before I died, and I wanted it so that I could enjoy it.' Now, Mr. Watson—

Judge Allen: Were you there at that meeting, Mr. Watson?

The Witness: No, I was not at that meeting.

Mr. Bemis: I have not concluded the question, if the Court please.

Q. Mr. Watson, recalling the testimony of Mr. Cowley [fol. 1877] that he proposed to build at his own expense a line of $2\frac{1}{2}$ miles to take service, and calling your attention further to Complainants' Exhibit 937 to refresh your recollection, are you able to say how much money Mr. Cowley offered to subscribe per month for extension of service to the—

Mr. Fitts: We object to that question as utterly irrelevant and immaterial, and I don't see what that has to do with the meeting.

Judge Allen: Objection sustained.

Mr. Fitts: And I would like to call the Court's attention to the fact that the part of the testimony of the witness Cowley which Mr. Bemis just quoted is part of the testimony to which I referred when he was testifying about the local mass meetings and the local movement for the organization of the cooperative.

Judge Allen: Objection is sustained to the question.

Mr. Bemis: Exception, and offer to show that if permitted to answer the witness would state that Mr. Cowley in the application for service made in 1932 subscribed for \$2 per month for extension of service to him. And if the Court please, I believe that has a direct bearing upon the credibility of this witness."

I am familiar with the lines now operated by the Lincoln County Electric Membership Corporation. Those lines were constructed commencing in March, 1935. The Lincoln County Electric Membership Corporation was organized about September, 1935, subsequent to the construction of the Lincoln County Electric Membership lines.

"Q. By whom were those lines constructed?

Mr. Fitts: There is no dispute about that.

Mr. Fly: We owned those until two weeks ago. That is all in the record.

Mr. Bemis: I understand there is no objection as to the date when these lines were constructed.

Mr. Fitts: The lines were built by the Tennessee Valley Authority and turned over later to the Lincoln County Electric Membership Corporation. All of the contracts are in the record. The whole history of the transaction is de-[fol. 1878] scribed in the record, in the contract.

Mr. Bemis: To clear up any confusion, are you willing to agree that the lines which are now operated by the Lincoln County Electric Membership Corporation were constructed sometime about March, 1935, and that the electric membership corporation was not organized until sometime subsequent, namely, in September of 1935?

Mr. Fitts: I understand the March date is wrong. But I think it is true some lines may have been constructed in Lincoln County before the cooperative was actually organized and doing business. I understand the March date is wrong, however. I am informed that that date is not the correct date."

(The witness was excused.)

"Mr. Bemis: I have two witnesses whose testimony will relate to this subject.

Judge Allen: What do you expect to show by them?

Mr. Bemis: I had better state that Mr. Hutchinson in his deposition stated that he had made a number of requests for service to the Tennessee Electric Power Company which had been ignored. Now, in substance I wish to show that is not the fact, that they had been investigated and that Mr. Hutchinson was told on what terms and conditions line extensions would be made to him. If the Court deems that to be irrelevant, I can perhaps state in the record, without calling the witnesses, what we expect to show.

Mr. Fly: We concede all that you have stated there.

Judge Allen: That is conceded?

Mr. Fitts: That is conceded, that the witnesses would so testify.

Mr. Bemis: Well, I don't know that that is satisfactory,

that the witnesses would so testify. Will you concede it is the fact?

Judge Allen: That is all you could show by your witness. You cannot show the facts by your witness, you can only show that the witness would testify to the fact.

Mr. Bemis: The Court is entitled to judge of the credibility of the witness.

[fol. 1879] Mr. Fly: It is conceded he is a credible witness.

Judge Allen: It is conceded he is a credible witness.

Mr. Bemis: I think that is tantamount to a concession that the facts are contrary to what Hutchinson testified.

Judge Allen: The understanding of the Court is it is tantamount to a concession that two credible witnesses contradict each other; is that correct?

Mr. Bemis: That is correct.

Judge Allen: In other words, there is a conflict in the testimony?

Mr. Fly: Except we don't think there is necessarily a conflict.

Mr. Bemis: I had mentioned to the Court I had two witnesses on this subject, on which testimony would be cumulative. Mr. Hall, J. M. Hall, who is district engineer in the local office, in the locality where Mr. Hutchinson resides, and Mr. C. P. Little, who is local manager in Murfreesboro, Tennessee.

Judge Allen: What do you expect to prove by them?

Mr. Bemis: They would both testify requests for service by Mr. Hutchinson had been investigated and that two reports had been made to him in regard to the cost of line extensions, and the cost of service, and that he had stated that he had no desire to have those line extensions made on those terms.

Mr. Fly: We will concede that, and make the score 2 to 1 now.

Mr. Fly: I want to make a statement with respect to the testimony of the witness Cowley which was put in question. I would like to give the Court references, if the Court desires to note that—I do not care to read them—but, as reported in Supplement A to the official transcript, the witness Cowley testified with respect to solicitation and coercion on the part of the Tennessee Valley Authority on pages 55, 56 and 60; with reference to duplication of lines on page 58; with reference to the fact that no customers

previously served by the power company were being served by his cooperative, on page 59; and with reference to the relationship existing between the cooperatives and the Tennessee Valley Authority on pages 66 and 67.

Judge Allen: The motion to strike from the record the deposition of the witness Cowley is now denied.

Mr. S. D. L. Jackson: May we have an exception?

Judge Allen: Yes."

[fol. 1880] WILLIAM P. CREAGER was called as a witness on behalf of the complainants and, having been first duly sworn, was examined and testified as follows:

—Direct examination:

I reside at Buffalo, New York, and I am a consulting engineer. My preliminary education was at the grammar school of Baltimore City, Baltimore City College, and at night school in Baltimore.

I am a civil engineer and a graduate of Rensselaer Polytechnic Institute of 1901 with a degree of Civil Engineer. I am a member of the following technical societies and committees: American Institute of Consulting Engineers, American Society of Civil Engineers, Society of American Military Engineers, International Association for Hydraulic Structure Research, International Congress on Soil Mechanics, American Geophysical Union, Executive Committee of Soil Mechanics Division, Am. Soc. C. E., Executive Committee of Power Division, Am. Soc. C. E., Chairman of Committee on Soil Mechanics Bibliography, Am. Soc. C. E., Member of Committee on Seepage, Am. Soc. C. E., Member of Committee on Dams, Am. Soc. C. E., Member of Committee on Valuation, Am. Soc. C. E.; and I am a licensed professional engineer in New York and California.

From 1901 to 1903, I was Provincial Supervisor in the Philippine Islands. From 1903 to 1906, I was designer on locks and dams for the New York Barge Canal. From 1906 to 1922, I held various positions from designer to chief engineer of hydraulic structures for the J. G. White Engineering Corporation. From 1922 to 1930, I was Chief Engineer and Vice President in charge of engineering and construction for several public utility corporations in New York, generating hydraulic power exclusively. From 1930

to date, I have been acting as a consulting hydraulic engineer. My thirty-six years of practice have been in the field [fol. 1881] of hydraulics and I have designed 26 hydro electric developments and supervised the construction of 15 of them. I have designed about 40 or 50 dams exclusively of my consulting practice and have supervised the construction of 13 of these. I have made designs, estimates and financial reports on about 200 hydraulic properties and my studies have involved work in 35 states and 9 foreign countries, including work for the Russian and Mexican Governments, and I have acted as consultant on a large number of flood control projects for the United States Army Engineers.

During the last two years of my consulting practice, I have been employed on Los Angeles Flood Control District, the Brazos River Conservation Dam, Texas, the Savage River Project, Maryland, the Mexican Commission of Irrigation, the Central Nebraska Public Power and Irrigation District, the Pittsburgh Flood Control District, the Black River Regulating District, New York, the Red River Flood Control Project, Texas, the Binghamton Flood Control Project, New York, the Los Angeles County Drainage Area, California, the Orange County Flood Control District, California, the Aluminum Company of America, and on a number of public utilities. I have also been engaged but have not yet started work on several other hydraulic projects, including one for the Argentine Republic. All of the projects on which I have been engaged as consultant during the last two years embodied the design, construction and operation of 25 authorized dams and many others studied for comprehensive systems, and eight of the aforementioned clients were engaged in the design, construction and operation of projects to be used primarily for flood control.

I am the author of the following technical books: Author of "Engineering for Masonry Dams", 290 pages; Co-author of "Hydro-Electric Hand Book", 880 pages; Associate Editor "Pender's Hand Book for Electrical Engineers", 2200 [fol. 1882] pages; Associate Editor "Reinforced Concrete & Masonry Structures," 770 pages; and Associate Editor "Kent's Mechanical Engineers Hand Book", 2100 pages. I am also collaborating to write as co-author a forthcoming

book to be entitled "A Treatise on Dams". Of the aforementioned publications, "Masonry Dams" has been translated into French and a large part of "Hydro-Electric Hand Book" has been translated into Russian.

In addition to the eight aforementioned clients which had the question of flood control as the primary objective, I have had a number of other clients which have had the question of flood control as one of their major problems and I have had a large number of cases prior to my consulting practice in which the question of floods was of great importance.

I have had the following special or local experience with the Tennessee River and its tributaries. I worked on the design of the Ocoee #1 and the Ocoee #2 developments on the Ocoee River. I did some consulting work on the Hales Bar hydroelectric plant, I designed the hydraulic intake system for the Muscle Shoals steam plant, and I designed the water supply system for two government nitrate plants near Florence. I made an examination of the site of Wilson Dam and I acted as consulting engineer for The Aluminum Company of America on the flood capacity and flood control features of its Santeetlah Dam. I also made or assisted in making a number of reports on hydroelectric projects on a number of the tributaries of the Tennessee and I visited Norris Dam during its construction. I did a great deal of original research for the benefit of my publications and among these I have made a very comprehensive study of floods through the United States and foreign countries. The flood characteristics of the dam and its flood territories were, of course, included in such studies.

I am familiar with the Tennessee Valley Authority Unified Plan in a general way.

[fol. 1883] "Q. Will you describe the modern methods by which the height of the dam and the volume of the storage space is determined for a project to be used solely for flood control purposes and for no other purpose whatever?"

Mr. Fitts: I object to that as improper rebuttal, it is purely an opinion.

By Judge Allen:

Q. Does that call for an opinion?

A. No, he asked me the modern methods, and I think they are very well established. It is not my opinion. If I an-

swered the question I would recite what the modern methods are as practiced by flood control engineers in general.

Judge Martin: What would it rebut?

Mr. S. D. L. Jackson: This line of questions is somewhat preliminary, the Court will appreciate that. I am leading up to a line of questions which will rebut testimony offered by the Defendants here.

Mr. Fly: Your Honor, I think this is pretty serious, to have this witness started off saying what his opinion is, and that his opinions represent the opinions of the profession, and how these dams ought to be built. It is going right back to the beginning. Assuming that he might touch upon some facts it must be his opinion, and it still would be improper rebuttal.

Judge Martin: We have been trying fairly and consistently throughout these hearings to exclude rebuttal of expert opinion testimony, but not proposed rebuttal of facts.

Mr. Fly: This matter of accepted standards in the profession naturally is an opinion.

Judge Allen: What is the fact that is testified to here as to modern methods contrary to what this witness will testify.

Mr. S. D. L. Jackson: Well, I don't know as anybody expressly testified as to modern methods, what modern methods were, but as I stated, this is preliminary, for the Court's information, to lay a ground-work for other testimony that will be produced. Of course, in any scientific or technical field, there are certain well-defined laws and principles that apply.

Judge Allen: And those you developed, you had opportunities to develop and you did develop in your case in chief, and the defendant answered. Now, here again, it is a reopening of the case as to modern methods, and there is no showing that anyone of the defendants' side said anything about modern methods, that this evidence will now dispute in this answer? The objection is sustained on the [fol. 1884] ground that there is no showing that the answer to this question would rebut anything in this record.

Mr. S. D. L. Jackson: May we have an exception, and an offer to prove that if the witness were permitted to answer he would state that under modern methods by which the height of a dam and volume of the storage space is determined, for a project to be used solely for flood control pur-

poses and for no other purposes whatever, the location of the reservoir and its capacity are determined from economic considerations and the suitability of the reservoir for a comprehensive flood control program, if any. The dam is built to the required height to provide the given storage and there is no need to build the dam higher than that required to give the required storage space, because if it were built higher than required, either there would be a waste of money or it would have been built higher for an additional purpose. It would not be possible to generate primary power at a dam which has been built solely for flood control purposes, because any storage space which is provided solely for flood control must be absolutely empty most of the time, and under such conditions there would be zero head, and without head there can be no power. It would not be modern practice to install generating equipment to obtain primary power at a dam built solely for flood control, and it would be necessary to build a dam higher than required solely for flood control in order that a head would be created for power generation.

Mr. Fitts: Of course, your Honor, there is another ground upon which this evidence would be excluded. It is irrelevant, anyhow.

Judge Martin: It has been excluded.

Mr. Fly: There is an important point there. Nobody has ever contended on the part of the defendant that there would be any power produced at any of these dams. There will not be any power at tributary dams. This is entirely irrelevant to anything brought out by us in our case.

Mr. S. D. L. Jackson: It goes in with the hookup of primary power.

Mr. Fitts: He is asking about a dam constructed solely for flood control, and the statute does not authorize the construction of any dam solely for flood control.

Mr. S. D. L. Jackson: Of course, the navigation angle has been covered by other witnesses.

[fol. 1884a] Judge Allen: This subject has certainly been gone over at length by the complainants. If there are any details of it that were not touched upon, they should have been touched upon in your case. It is not proper rebuttal.

Mr. S. D. L. Jackson: May we have an exception?

Judge Allen: Yes.

I have seen Complainants' Exhibit 362 before and have examined it.

"Q. I call your attention to the dam and reservoir indicated on the left of that exhibit. Suppose that at this dam site flood control and power were the sole consideration. Suppose that only the available storage space at elevation 1020 were needed for flood control, would you say that the dam had been built solely for flood control?

Mr. Fitts: We object to that on the grounds previously stated.

Judge Allen: Objection sustained.

Mr. S. D. L. Jackson: May we have an exception?

Judge Allen: You may.

Mr. S. D. L. Jackson: If the witness were permitted to answer this and subsequent questions relating to the same subject, he would testify, that under the assumptions in the question, that the dam would not have been built solely for flood control, because it was higher, and the storage [fol. 1885] space would have been greater than would have been necessary solely for flood control. Under the same assumptions, except that only the available storage space above elevation 955 were needed for flood control, he would be of the same opinion.

Q. Mr. Creager, suppose that in comparison with a dam built at this site solely for flood control purposes, this dam on the left was about 20 per cent higher, contained about 90 per cent more storage space; costing with its power plant, about 340 per cent more, and in addition, the value of its annual power output was many times the annual flood benefit, would you consider it primarily a flood control project?

Mr. Fitts: We object to that on the same grounds.

Judge Allen: Objection sustained.

Mr. S. D. L. Jackson: Exception, and if the witness were permitted to answer he would state that under the assumptions contained in the question, he would consider such dam primarily a power project. In designing a dam solely for flood control and for low water regulation below the dam, the lowest discharge facilities would be located just as low as it would be possible to built them, and usually at the bottom of the reservoir, as shown by the proposed dam sketched on the right side of Exhibit 362. If a dam such as the dam on the left of Complainants' Exhibit 362 were constructed

solely for flood control and low water regulation, the discharge outlets would be located considerably below where they are shown to be.

The witness, in answer to subsequent proper questions directed to the same subject, if permitted, would testify that he is of the opinion that if the Norris Dam had been built solely to create a reservoir for the combined purposes of flood control and low water regulation on the stream, there would be no opportunity for economic generation of primary power at such a dam, because if it were built for combined purposes of flood control and low water regulation, it would necessarily have to be quite empty during the time of extreme low water on the stream, and at such times there would be no head available for power generation at the site. That, in his opinion it would not be possible to obtain economical incidental power from the dam for the purpose of assisting the rest of the system in the generation of primary power, because the rest of the system needs supplementary power in order to firm up its output only during the low water season and at such times the Norris Dam reservoir would be empty. That the only conditions under which it would be possible to generate economic power for any use in a primary power market from a power installation provided at a dam which was alleged to have been built solely for flood protection and low water regulation, or that the dam must have been built higher than was necessary for the sole purpose of flood protection and the regulation of low water flow, thus creating a permanent minimum head which necessitates some dead or wasted storage space.

[fol. 1886] Q. Mr. Creager, what is dead storage?

Mr. Fitts: We object to that, it calls for an opinion, it is not a fact.

Judge Allen: The objection is sustained.

Mr. S. D. L. Jackson: May we have an exception?

Judge Allen: The question is leading up to a question of opinion?

Mr. S. D. L. Jackson: That is correct, your Honor, and if the witness were permitted to answer this question and other questions relating to the same general subject matter, he would state that dead storage is never used for any purpose, the water surface is never lower than the elevation of the top of dead storage. It is automatically created to obtain head for power or surface areas for a lake for

pleasure or other purposes. When dead storage is present at a dam built allegedly solely for flood control and/or low water regulation, the witness is of the opinion that the dam has been built higher than necessary for use as a flood control and/or low water regulation dam, and extra expense is incurred in providing dead storage because the dam is higher than necessary.

Judge Allen: The Court is wondering, Mr. Jackson, why you did not offer these various experts in your main case? The Court would have permitted them to testify on these points, and that would have avoided additional testimony on the same subject.

Mr. S. D. L. Jackson: Was that question asked me on the record.

Judge Allen: Yes, it was asked on the record. We have been wondering why—I have consulted with the other two judges—why this evidence is offered now, when, evidently from the conduct of the case it would have been admitted at the proper point in the complainants' presentation as original testimony.

Mr. S. D. L. Jackson: In our view, if the Court please all of this evidence is proper rebuttal as we understand the rule that applies to rebuttal evidence. We are in the unfortunate position of the Court refusing to accept our view on that issue, or on that question, but we are sincere in the belief that all of this testimony is proper rebuttal. It is designed to controvert evidence which was produced here by the defendant.

Judge Allen: Well, we merely note that this evidence could have been produced in chief.

Mr. S. D. L. Jackson: And it has been suggested that when the defendants' witnesses took the stand and gave testimony that appears in this record, it put into the case [fol. 1886a] matters which we thought even had we attempted to have offered them in our own case in chief, the Court would probably, in our view, at least, at that time, would have stated that we were going into matters that would have no proper relation to the case in chief."

I have examined Complainants' Exhibit 352 which is labeled, "Location of System of Flood Control Reservoirs." I understand that it was presented by Mr. Kurtz and that this system is his recommended system in this case. I understand that 19 reservoirs are involved there.

"Q. What is the total acre feet of dead storage space indicated for those 19 reservoirs?

Mr. Fitts: We object to going over exhibits which are already in, and saying what is in them.

Judge Allen: Objection sustained.

Mr. S. D. L. Jackson: Exception, and if the witness were permitted to answer, he would state, 6,024,000 acre feet of net storage space indicated on those 19 projects."

I have examined Complainants' Exhibit 354 labeled "Tennessee Valley Authority Unified Plan Recommended to Congress," which is an exhibit out of the report filed March 31, 1936.

"Q. How many reservoirs does that exhibit show are involved above Chattanooga?

[fol. 1887] Mr. Fitts: We object to the examination or repetition.

Mr. S. D. L. Jackson: This is merely preliminary.

Judge Allen: Preliminary to an expression of opinion?

Mr. S. D. L. Jackson: A series of opinions.

Judge Allen: The objection is sustained. The exhibit is in evidence, we are quite familiar with that part of the record.

Mr. S. D. L. Jackson: May we have an exception to the Court's ruling? If the witness were permitted to answer this question and further appropriate questions relating to the same general subject, the witness would testify that he has examined Complainants' Exhibit 352, and understands that it was presented by Mr. Kurtz in this case, and that it involves 19 reservoirs; he has also examined Complainants' Exhibit No. 353, which he understands has application to the reservoirs recommended by Mr. Kurtz in this case. If the drainage area above Chattanooga is 21,400 square miles then upon the basis of the data appearing in Exhibit 353, the reservoirs indicated on Complainants' Exhibit 352 control about 78 per cent of the drainage area above Chattanooga; that he has examined Complainants' Exhibit 354 and has noted that six reservoirs are involved above Chattanooga. He has examined the data contained on Complainants' Exhibit No. 355, and assuming 21,400 square miles as the drainage area above Chattanooga, only about 26 per cent of such drainage area is

controlled at Chattanooga under the TVA Unified Plan recommended to Congress, as set out on Complainants' Exhibit 354. That he is of the opinion that for flood control above Chattanooga, the system indicated on Complainants' Exhibit No. 353, the Kurtz' exhibit, is much superior to the TVA system as set forth on Complainants' Exhibit 354, assuming that each is built according to accepted practice of detailed design and construction. That a flood control system built solely for local protection must increase the peak in the main river occasionally. However, where there are two or more such local systems, above a given main stream, the combined effect would be an improvement on the main stream. Because of this all flood control projects of which he has knowledge are designed for local protection, although many of them afforded flood protection also to the main streams. As an example, the witness notes that the general system of flood protection provided in plan two of the Mississippi River Commission as contained in Defendants' Exhibit 32 is a system of reservoirs for local flood benefits with incidental benefits on the lower Mississippi.

[fol. 1888] Q. Mr. Creager, in modern engineering practice is it necessary that before a flood control dam is built, a decision must be reached with respect to the volume and size of the flood which it is proposed to control?

Mr. Fitts: We object to that, may it please the Court, on the same ground.

Judge Allen: The objection is sustained.

Mr. S. D. L. Jackson: May we have an exception. And if the witness were permitted to answer this question and other appropriate questions relating to this same general subject, he would state that in modern engineering practice, before a flood control dam is built, a decision must be reached with respect to the volume of the flood which it is proposed to control. Under the assumption that the period of record for floods on the Tennessee River is about 50 years, and that the site of the dam is to be at the site of the Norris Dam, in his opinion it would not be in accordance with good modern engineering practice to design a dam for the purpose of controlling a flood no larger than one which has been recorded in the previous 50 years.

The reason for this is that a certainty exists that a greater flood will occur in the future than has occurred in the last

50 years. Under modern practice floods of record are only a small part of the total evidence used to determine flood projects which are usually taken to be between 150 per cent and 200 per cent of the maximum of record, and sometimes more.

He cannot describe briefly the methods used in the determination of the flood for which adequate protection should be provided, because such a consideration would involve a number of facts, including meteorological data, storms of record, floods of record, percent run-off, period of concentration, valley storage, vegetable cover, geological structure, topography.

Q. Mr. Creager, I show you Defendants' Exhibit 90, and I shall ask you to assume that the rate of filling of such a reservoir is such that the reservoir would stand at elevation 955 on December 15th, and that filling would proceed at a uniform rate with respect to the volume to an elevation of 1005 on April 15th, and that after that date the filling might extend to the top of the spillway if sufficient water were available. What, in your opinion, is the method of operation which I have asked you to assume?

Mr. Fitts: We object to that as not proper rebuttal.

Judge Allen: The objection is sustained.

[fol. 1889] Mr. S. D. L. Jackson: Exception. And if the witness were permitted to answer, he would state in response to this question and other appropriate questions relating to the same subject, that he had examined Defendants' Exhibit 90. Under the assumption that the rate of filling of such a reservoir is such that the reservoir would stand at elevation 955 on December 15th, and that filling would proceed at a uniform rate with respect to the volume to an elevation of 1005 on April 15th, and that after that date the filling might extend to the top of the spillway if sufficient water were available, it is his opinion the method of operation assumed would indicate that it provided an elevation of water surface below which under ordinary conditions head and/or storage would be available for another purpose, such as the production of power, and under modern engineering practice, a rule of operation such as that assumed would be unnecessary, and quite useless, if such a dam were operated for flood control purposes only. However, if the dam is to be used for the production of power or any other purpose than flood control, involving

the production of power, some such rule for filling the reservoir would be useful."

I am familiar with the hydrological conditions of the eastern United States which, of course, includes the Tennessee River.

"Q. I refer you to Defendants' Exhibit 90 and ask you to assume that 1,312,000 acre feet of storage space is necessary for flood protection, and that no more than 1,312,000 acre feet is available above elevation 990. In your opinion, would the rule of operation indicated on Defendants' Exhibit 90 be satisfactory?

Mr. Fitts: We object to that, may it please the Court, on the same ground.

Judge Allen: That calls for an opinion. Objection sustained.

Mr. S. D. L. Jackson: May we have an exception. And if the witness were permitted to answer he would state in response to this question and to other appropriate questions relating to this same subject, that in his opinion the rule of filling set out on Defendants' Exhibit 90 is not consistent with modern flood control practice as applied to flood protection at Chattanooga, assuming that 1,312,000 acre feet is required for such protection, and that no more than that amount of storage space is available above elevation 990. This is because all records of flood are notoriously undependable, and floods of large magnitude might occur during periods in which historical records have indicated that large floods have not occurred. Therefore, there is a great [fol. 1890] probability that floods of large magnitude might occur considerably after the period of encroachment on flood storage indicated by the method of operations shown on Defendants' Exhibit 90. He is of the opinion that it would be extremely hazardous not to have that flood storage available.

Q. Mr. Creager, would you consider it good modern practice in engineering where automatic gates are used to control large volumes of water to equip such gates also with hand control?

Mr. Fitts: We object to that, may it please the Court.
Judge Allen: Objection sustained.

[fol. 1895] Mr. S. D. L. Jackson: That came at some later time, after you had telephoned to your budget officer in your Knoxville office or someone, and received advice from someone there.

Judge Allen: Now, with reference to the subpoena duces tecum for the minutes of the directors relating to methods of operation of Norris and Wheeler Dams, the Court has consistently held testimony with reference to methods of operation of these dams and projected dams is competent and material if properly presented. Material testimony covering the same subjects as this application for subpoena duces tecum was given on behalf of the defendants in this case prior to the Christmas recess. It is the memory of the Court that Mr. Woodward concluded his testimony, both direct and cross, on December 18th.

Why is this application for subpoena duces tecum asking for minutes relating to methods of operating Norris or Wheeler Dams, or establishing rule curves, or establishing rules for the filling and lowering of the reservoirs at said dams, and for minutes prescribing levels at any of the reservoirs of the TVA dams not asked or brought into Court, at least, during the progress of the defendants' case? Why is it asked for on rebuttal?

Mr. S. D. L. Jackson: I might state in answer to that, if your Honor please, that on the last day, I think, the last day of the defendants' case, they produced in response to a request from us, a water control memorandum, those which were made by Mr. Llewellyn Evans and Mr. Woodward, prior to July of this year when they were acting as a committee, which I think appears from the Defendants' Exhibit 61 or 65.

They also produced—I might state in response to that, or in addition to that, they produced then about eight or nine so-called water bulletins, or water control memoranda. That is Complainants' Exhibit, I think, 923 of this record. It was only brought in and given to us, I think, on the last day of the defendants' case. At the bottom of each sheet of that exhibit, of these eight or nine water control memoranda, appears the notation: 'Approved by the Board of Directors,' which indicates obviously, that there are other minutes of the board of directors relating to these matters which were not produced at any time. Now, subsequent to July of this year, there were also produced and marked, Complainants' Exhibit 924 of this record, a number of

water control memoranda signed by Mr. Woodward or someone for him. Those did not bear any such notation.

Now, our subpoena, when we were advised that there are certain minutes of the board of directors expressly relating [fol. 1896] to this very material, I think our subpoena was timely presented.

Mr. Fly: May it please the Court, I think it would be helpful if I would again state that they have had all of the resolutions on this subject. There are no more. The only result of ordering this subpoena is for me to come in here again and make that same report.

Mr. Fly: . . . May it please the Court, pursuant to the ruling of the Court, we have checked the 43 pages, as many as were submitted to us—

Mr. S. D. L. Jackson: 47.

Mr. Fly: Of a photostatic copy of a 48 page document entitled 'Tennessee Valley Authority detailed statement of budget estimates for the fiscal year ending June 30, 1939'. Except for the missing pages and except that several of the figures and computations appearing on the original in red ink have been in the process of copying changed to an indistinguishable dark color, this photostatic material appears to be an accurate copy of a document which the authority submitted to the Subcommittee of the House Committee on Appropriations in charge of appropriations for the Authority. Counsel for complainants have stated in open Court that this photostatic copy was secured by them two days after the recent hearings held by the Appropriations Committee of the House of Representatives on the Tennessee Valley Authority appropriations. These hearings were held on December 13, 1937.

I want to make this statement to the Court in absolute frankness and explain the embarrassment which this incident has created. The Government regards this document as wholly incompetent and irrelevant.

[fol. 1897] I want to emphasize, however, that there is nothing in it which we have any occasion to fear. However, in deference to the Appropriations Committee, itself, I am compelled to state candidly the circumstances under which the information was compiled for and supplied to and held by the Committee.

The photostats which complainants have are taken from a report which the Tennessee Valley Authority prepared

Mr. S. D. L. Jackson: Well, I think that counsel now have a book there, and can readily authenticate it, and I understand they had examined the other sheets which we submitted to them this morning, and have made a statement that so far as authenticity was concerned—

Judge Gore: These are the two missing sheets from what you handed them this morning?

[fol. 1901] Mr. S. D. L. Jackson: That is one of the two sheets missing from what I handed them this morning, and the other one is 925 in evidence.

Mr. Fly: They have got three or four others missing from this document.

Mr. S. D. L. Jackson: I think perhaps that is right, but anyhow those are two of the small number of missing sheets that there were, and the others—I don't know where they are, I think some of them were given exhibit numbers.

Judge Allen: Do you claim that these are anything more than preliminary figures?

Mr. S. D. L. Jackson: Why, based on counsel's statement, Mr. Fly's statement made to the Court about December 16th, they are the figures that were submitted to the Subcommittee on December 13th. I have no means of knowing whether they are preliminary, final, interim or what not. I think they were figures, based on that statement, that were actually handed to the Committee, and concerning which the defendants—

Mr. Fly: Tentative figures. The final figures are in the proceedings and are in evidence.

Mr. S. D. L. Jackson: They were submitted to them in support of an appropriation request for some forty million dollars.

Mr. Fly: And changes were made during the time the committee considered it, and the committee acted upon the final figures which are published by the committee as its official record of its full action.

Mr. S. D. L. Jackson: Do you know that that is a fact?

Mr. Fly: It clearly is.

Mr. S. D. L. Jackson: In view of Defendants' Exhibit 153 it appears that the tables were submitted to the committee in the form I presume in which they appear on that sheet, and that then they were revised sometime after that and before December 20th, 1937.

Mr. Fly: Before the committee action?

Mr. S. D. L. Jackson: The Board resolution with respect to certain of that data is dated December 20, 1937.

Judge Allen: Is there any statutory requirement for submitting this particular set of figures to the Congress?

Mr. Fly: No, your Honor, I don't think there is any statutory requirement for submitting that particular set of figures.

[fol. 1902] Judge Allen: There is a statutory requirement for submitting the usual hearing report.

Mr. Fly: For submitting general data, yes, your Honor, and the custom is to submit those in preliminary form, they are gone over with the committee and certain changes made at that time, to make them clearer, and then they are checked up, and then finally the committee makes up its final official table, and then takes action.

Mr. S. D. L. Jackson: One purpose of this is to bear upon the credibility of certain witnesses offered by the defendants, on this action.

Mr. Fly: You don't mean that.

Mr. S. D. L. Jackson: Yes, I do mean just that.

Mr. Fitts: It doesn't bear on their credibility because they stated the full facts about that.

Mr. Fly: There is no question of credibility involved here. The main question is how you got these confidential figures. In fact you got the official budget hearings two days before I could get them.

Judge Allen: Mr. Jackson, you doubtless have stated, but please restate the exact facts which you claim that this set of figures rebuts.

Mr. S. D. L. Jackson: The witness Bowman, when he took the witness stand, and that was I think on December 15th or 16th, testified as to certain figures which he then said were the figures with respect to various of the projects of the Authority.

Mr. Fly: Specifically the height of Gilbertsville Dam.

Mr. S. D. L. Jackson: And I think perhaps other things.

Judge Allen: Just a minute, Mr. Fly. We have asked Mr. Jackson a question and we would like to get an answer.

Mr. S. D. L. Jackson: Now, it appears that the figures to which he testified were divergent to figures which the Tennessee Valley Authority had presented to Congress in April of 1937, and which were set forth on page 403 of Complainants' Exhibit 116. On cross-examination Mr. Bowman

Mr. S. D. L. Jackson: May we have an exception. And if the witness were permitted to answer, he would state in response to this question and other appropriate questions relating to the same subject that it would be good modern practice in engineering where automatic gates are used to control large volumes of water to equip such gates also with hand control, and it is a simple operation to change from automatic to hand control.

If the automatic feature provided for sluice gates in a flood control dam were broken, or if the automatic rule of operation at any time was not in conformity with the desired or correct operation, it would take only a few moments to change over to hand operation. The only harm that could possibly result from equipping a flood control dam with automatic operating flood gates for use after filling would be in the expenditure of money for the automatic feature. The provision of such automatic feature would in no way affect the efficiency of the project because at any time it would be perfectly feasible to abandon the automatic feature. The elimination of the automatic feature could not lessen the value of such reservoirs.

The Court requested yesterday that in offering each witness which we offered in rebuttal, we were to state the reference to the defendants' testimony which the testimony of the witness was designed to rebut. I don't believe that was given with respect to Mr. Creager, when he was called this morning.

Judge Allen: But all of the questions which you have asked either lead up to or call for opinion evidence?

Mr. S. D. L. Jackson: Yes, your Honor, that is correct. But the testimony, if I might make just this very brief statement,—the testimony of Mr. Creager would relate to subjects including those testified to by the witness Woodward and the witness Kimball to the general effect that the purpose of Norris Dam is primarily flood control, and [fol. 1891] merely incidentally the production of power.

Judge Allen: It would also relate to the testimony given by your witnesses in chief to the same effect as that of Mr. Creager's.

Mr. S. D. L. Jackson: Mr. Creager's testimony is designed to rebut, and the purpose of producing Mr. Creager is to rebut the testimony of the defendants' witnesses.

Judge Allen: General testimony to the same effect was given by your witnesses in chief.

Mr. S. D. L. Jackson: Oh, Mr. Kurtz, I believe testified on that subject in the case in chief, but at that time of course there had not been brought into or there had not appeared in this case this curve set forth in Defendants' Exhibit 90, and Mr. Kimball and Mr. Woodward had not stated the method of operation that they proposed, or it was stated in the defendants' case that they proposed to follow, in the operation of that dam and the other dams of the system,—the Court will recall that both of those hydraulic witnesses on the case in chief dealt with the problem of flood season, and of seasonal filling.

Judge Allen: The Court is following the usual rule with reference to that in all courts.

Mr. S. D. L. Jackson: That the testimony of Mr. Creager would relate also, or rebut also testimony of the witness Kimball to the effect of deficiencies in the Kurtz' system of reservoirs.

It would also rebut testimony of the witness Kimball as to the method of selecting project floods. Mr. Kimball undertook to state methods of determining project floods, and Mr. Creager's testimony is designed to rebut that testimony by showing that such method is improper, that the rule of filling curve, Defendants' Exhibit 90 introduced for Norris Dam by the witness Kimball, is not a proper curve for flood control operation; that the method of operation of Norris Dam testified to by the witness Kimball is an improper one for flood control, and that contrary to testimony of the witness Kimball provision for automatic control of the reservoirs recommended by the witness Kurtz would not lessen the value of the dams he proposed for flood control."

(The witness was excused.)

"Mr. S. D. L. Jackson: Now, with respect to this ruling which the Court made, I think it was yesterday morning, the complainants wish to be satisfied that we are correct in understanding that the Court's ruling with respect to the introduction of testimony in rebuttal by expert testimony, or by expert witnesses is to the effect that no such testimony [fol. 1891a] should be admitted of the same witnesses—if the same involves an expression of opinion—

Judge Allen: Whatever the ruling of the Court was when you reopened the case, on the expression of opinion, that is not proper rebuttal. Wherever experts testify and cover

a subject, they have an opportunity to say all they want to, and give all of the expressions of opinion they wish, and then the defendants' experts answer on that, our holding is that you cannot reopen the case and bring in the same expert or new experts to say all over again the things which you might have said the first time while you had these subjects before you. That is not proper rebuttal."

[fol. 1892] Counsel for complainants offered in evidence, as a part of their case in chief, and the Court received as Complainants' Exhibit 942, a graph setting forth the loads of all the complainant companies by weeks for the calendar year 1937 and an attached sheet containing the reading by weeks of the figures contained on the graph.

Counsel for complainants offered in evidence, as a part of their case in chief, and the Court received as Complainants' Exhibits 943 to 953, inclusive, certified and exemplified copies of the charters of the following cooperatives organized in the state of Mississippi: Lee County Electric Power Association (Exhibit 943), Alcorn County Electric Power Association (Exhibit 944), Monroe County Electric Power Association (Exhibit 945), Pontotoc County Electric Power Association (Exhibit 946), Prentiss County Electric Power Association (Exhibit 947), Tishomingo County Electric Power Association (Exhibit 948), 4-County Electric Power Association (Exhibits 949 and 950), Tippah Electric Power Association (Exhibits 951 and 952) and Northeast Mississippi Electric Power Association (Exhibit 953).

COLLOQUY

"Judge Allen: At this time the Court would like to have certain information, Mr. Jackson. There are two applications for subpoena duces tecum before us. One calls for the Tennessee Valley Authority's detailed budget estimates submitted to Congress in December, 1937, containing pages 1 to 47, both inclusive. When was this budget estimate submitted to the Congress?

Mr. S. D. L. Jackson: It was submitted to the Subcommittee of the House Committee on Appropriations at a hearing, I think the date is December 13, 1937.

Judge Allen: The other application for subpoena duces

tecum which relates to this same detailed statement,—does it not Mr. Jackson?

Mr. S. D. L. Jackson: There is another subpoena calling for certain specific pages of the same report.

[fol. 1892-a] Judge Allen: Yes. For pages 7 and 8, 9, 10, 11, 14, 15, 30, 31 and 32, and describing in detail the material contained upon those pages. The Court in considering an application of this kind on rebuttal is compelled, of course, to satisfy itself of the competency and relevancy and materiality of the evidence sought to be furnished. Do you have a copy of this detailed statement, Mr. Jackson?

Mr. S. D. L. Jackson: We have, if your Honor please, a photostat of what we think was a copy of it. That is, we feel confident, in answer to your Honor's question, we feel confident that the information which is on the thing we have is the information that was actually presented to the Committee.

Judge Allen: When did you receive it?

[fol. 1893] Mr. S. D. L. Jackson: It came to us sometime after December 13th.

Judge Allen: Yes. How long after December 13th?

Mr. S. D. L. Jackson: Within a couple of days.

Judge Allen: The Court would like to see the photostat.

Mr. S. D. L. Jackson: We have,—I am informed, this is incomplete, certain sheets are out. I took some of them out in connection with Mr. Raymond Jackson's examination of one of the recent witnesses,—of Mr. Bowman, I believe.

Judge Allen: Of Mr. Bowman.

Mr. S. D. L. Jackson: I think that exhibit is the one with his signature on it.

Judge Allen: Why was not this application for subpoena duces tecum, since you received this material about two days after December 13th, not made during the progress of the defendants' case? Why is it made on rebuttal?

Mr. S. D. L. Jackson: For this reason, your Honor, first, our case in chief had closed, your Honor recalls, before that date.

Judge Allen: I remember that, but I am asking why it is introduced on rebuttal.

Mr. S. D. L. Jackson: I don't believe we have any right to subpoena documents while our adversaries are going forward with the lawsuit.

Judge Allen: I think you have a right to ask the Court to order them produced.

Mr. S. D. L. Jackson: Well, if your Honor will recall, when this question first came up here about December 16th Mr. Fly then said he would be very glad to produce them. Your Honor recalls that. Now, we mentioned on one or two occasions after that during the course of the defendants' case, and nothing was at that time ordered by the Court, and the document was not produced. Now, Mr. Fly said, if your Honor will recall, when we first mentioned this report in connection with Mr. Bowman's testimony, the first time he was on the stand, that he would be very glad to produce it.

Mr. Fly: I want to be clear on that. I said if the Committee released it.

Judge Allen: Just a minute. Have you finished your statement, Mr. Jackson?

[fol. 1893-a] Mr. S. D. L. Jackson: I beg your pardon?

Judge Allen: Have you finished your statement?

Mr. S. D. L. Jackson: No. Then later on that same afternoon, after recess, Mr. Fly came in and reported to the Court that he had checked with their budget officer by telephone, and he then stated that certain of the information and figures which had been used by Mr. R. T. Jackson in examining Mr. Bowman were correct.

Judge Allen: Now, Mr. Fly, the Court would be very glad to hear from you with reference to this.

Mr. Fly: I would like to examine that.

Mr. S. D. L. Jackson: Well, I am sorry.

Mr. Fly: May I not examine it?

Mr. S. D. L. Jackson: I see no reason. I take it he has it. He handed it up to the Court.

Mr. Fly: It is the first time I have seen that copy.

Judge Allen: If you will permit counsel to examine it, and if there was no question of authenticity, then a very serious question would be disposed of for the Court.

Mr. Fly: I am trying to get someone here who is familiar with these things now, your Honor. I want to state that I never stated that I would volunteer to produce in Court any tentative or confidential figures submitted to the Committee unless they were released by the Committee.

[fol. 1894] Judge Allen: The Court, with reference to this particular detailed statement of budget estimates will ask counsel for the Authority to check it and report promptly to the Court whether or not it is authentic. And the Court

will withhold ruling on that matter until that question is determined.

Judge Allen: And your only answer to the reason why this is offered on rebuttal is that you could not make an application for subpoena duces tecum during the progress of the defendants' case?

Mr. S. D. L. Jackson: No, that is not correct, your Honor. I stated what my impression of the law was on that. I have had the subpoena ready for some time, but we expected that this document would be produced by the defendants.

And, if your Honor will recall, we raised that question on one or two occasions since December the 16th or 17th when the question was first up. We stated that they had stated that they would produce it, and it was not forthcoming, and they rested without producing it.

Judge Allen: Now, with reference to the application for subpoena duces tecum for the minutes; this, like the other two applications for subpoena duces tecum, was offered on the first day of rebuttal testimony. That is correct, Mr. Jackson, isn't it? You offered it during the course of the rebuttal?

Mr. S. D. L. Jackson: I think we presented the subpoenas to the Court on the morning we started our rebuttal testimony, and after the defendants' case had rested, and we were ready for the rebuttal.

Judge Allen: But after you had started the rebuttal?

Mr. S. D. L. Jackson: Yes, I think that is correct.

Judge Allen: Yes. That is, it was offered in the course of rebuttal testimony?

Mr. S. D. L. Jackson: Might I interrupt the court for just one moment? On page 3856 of the (stenographic) record there was some colloquy between Mr. Fly and Mr. R. T. Jackson, which ended with Mr. Jackson stating 'Do you want to produce a copy of the data, Mr. Fly? Mr. Fly: I haven't got it, but I will be happy to produce it after this goings on.'

Mr. Fly: And if you will read on you will find that I referred to the executive session of the committee, that the matter could not be released without the permission of the committee, and that I would be bound by the committee's action in that regard?

and submitted to the House Appropriations Committee, shortly before the hearings on our budget. By the direction of the Committee, and for reasons with which the Authority has nothing to do, the report is held confidential subject to the disposition of the Appropriations Committee and the Appropriations Committee alone.

The report as submitted is in somewhat tentative form, is used in the hearings at the discretion of the Committee, parts of such reports are sometimes inserted in the record of the hearings by the Committee's directions, and very frequently as the hearings will progress and as it is necessary to recheck matters, substantial changes are made in the final form of the Appropriations Committee's printed record of the matters dealt with in the report. The official record of the committee which constitutes the only official basis of its action, and the only final and official record of the report of the Tennessee Valley Authority to the Committee is now printed and has been introduced by the defendants and received by the Court as Exhibit 153. To the extent that that final report records differences in matters of detail from this tentative and confidential report, the reasons for such differences will be apparent, I think, in every case in the official report of the hearings. This is, in my opinion, in effect, an effort to go behind the official action of the Appropriations Committee and would result in a violation of the confidential character imposed upon these tentative figures by that committee in executive session. The committee, so far as I know, has never authorized the release or publication or distribution of any of these tentative and confidential figures. I am informed by the budget officer of the Authority that the chairman of the Subcommittee of the Appropriations Committee in charge of the Authority's budget has expressed concern to him over the reports that parts of this confidential document have already somehow appeared in this trial.

As I have indicated, the document as has been delivered to us by counsel for the complainants omits certain pages which appeared in the report submitted to the Committee, and certain of the data does not appear distinctly. If the Court so desires, I am willing to assume responsibility for submitting for the Court's examination, a complete and accurate copy of the report as the Authority delivered it to the Appropriations Committee.

My only concern in this matter arises out of my belief that not only the Authority, but also, in my opinion, counsel and the Court are under a duty not to violate the rules of the Appropriations Committee with regard to the disposition of material of this character.

Judge Allen: The question is before us on the allowance of the subpoena duces tecum. We understand from this statement, Mr. Fly, that that part of the detailed estimates that you have checked is correct, but that certain parts of its are missing.

Mr. Fly: That is right, your Honor.

Judge Allen: That is right. You doubtless have the other parts.

Mr. S. D. L. Jackson: Oh, my recollection is that I took those pages out and gave them to Mr. Jackson at the time he was examining a witness, so I presume they are still in our possession. One of them is in evidence, Complainants' Exhibit 925.

Judge Allen: Since you have the document, and so far as the authenticity is concerned, it is conceded, what legal ground is there for issuing any subpoena duces tecum for this detailed estimate or for any page thereof?

Mr. S. D. L. Jackson: The Authority's concession of authenticity does eliminate one question which gave us some concern about whether or not we had the document that was authentic. Do I understand you gentlemen have an authentic copy of that which you are going to hand to the Court?

Mr. Fly: Understand I am not offering an authentic copy here for counsel, but for the confidential use of the Court. The Court may examine my copy, but since you have a copy and since there are no inaccuracies, so far as the form is concerned, there must be no question left on a subpoena duces tecum. He has got his copy, already.

Mr. S. D. L. Jackson: If I may state to the Court the purpose, if the Court will refer to page 1077 of the Defendants' Exhibit 153, which defendants put in evidence the last day of their case, in a letter to Chairman Woodrum, chairman of the Subcommittee on Independent Offices Appropriations of the House Committee on Appropriations, it appears, or it is stated in that letter that 'In order to advise [fol. 1899] the committee of the latest information available in our projects we suggest that the tables already sub-

mitted to you be revised in line with the latest action.' Now, from that it is apparent that certain tables which were submitted to the House Subcommittee on Appropriations on December 13th were revised by the Authority, as appears from this letter which is dated December 20, 1937.

Mr. Fly: That is precisely my point. The official record shows it.

Mr. S. D. L. Jackson: Now, these are tables prepared by the defendants.

Judge Allen: Submitted to the Congress on December 13th, 1937?

Mr. S. D. L. Jackson: Yes, that is correct.

Judge Allen: And, in your hands on December 15th, 1937?

Mr. S. D. L. Jackson: I think that is correct.

Judge Allen: Now, it is the general rule that a motion or application for subpoena duces tecum should be made in such time that it will not delay the trial. Here we are now during rebuttal presented with these two applications that the Court should issue an order to produce a document that you have. The entire Court feels that the two applications relating to this particular document should be and they are refused.

Mr. S. D. L. Jackson: Might we have an exception?

Judge Allen: You may have an exception.

Mr. S. D. L. Jackson: To the Court's refusal of each. And might I ask that these applications for subpoena duces tecum be given each an exhibit number. (Complainants' Exhibits 954 and 955)

Judge Allen: Yes.

Mr. S. D. L. Jackson: If the Court please, when this document was handed to our friends on the other side there were certain pages missing. I have ascertained that Complainants' Exhibit 925 which is in the record was one of the pages which was missing. That was page 9.

Exhibit 926 was marked for identification in connection with Mr. R. T. Jackson's cross examination of the witness Bowman, and it was not offered in evidence.

And the page which bears the reporter's stamp, '926', which is page 10, and is described at page 5744 and 5745 (of the stenographic record) in a question, after the document was stamped Exhibit 926—'I show you complainant's exhibit 926 for identification, marked page 10, which fol-

lows exhibit 925 which you have just identified, and ask you whether the tabulation does not show,—or whether that tabulation does not correspond with the design for Gilbertsville shown on Exhibit 925, which is approved by you'.

And there is some discussion about it on that page. Now, might I be permitted to have the reporter stamp this page, page 10. another photostat of the same page, as Complainants' Exhibit No. 926?

[fol. 1900] Judge Allen: Is there any objection?

Mr. Fly: I object to that, your Honor, on the ground that would be a gross breach of duty of counsel and of the Court towards Congress. This is a matter of immaterial detail. The full record of the final action of that committee is here in this record, and I will not be a party to any business of this sort, of pulling that out of the executive session—

Judge Allen: Let us look at it.

Mr. Fly: If it is suggested that it be put in, your Honor, I want a witness put on who can state how it was procured, and we can ascertain whether or not it was actually a breach of the rule of Congress, and the duty towards the Congress. It is a matter of irrelevant detail anyway.

Mr. S. D. L. Jackson: I am merely now asking that the reporter be permitted to mark that sheet which your Honor has complainants' exhibit No. 926 for identification in place of the similar sheet that was so marked a few days ago.

Mr. Fly: I cannot be a party to that unless the witness gets on the stand and clarifies this matter. I object to it.

Mr. S. D. L. Jackson: I now have a copy of that which bears the stamp, I don't know if those are the reporter's figures. It may be several have been stamped.

Judge Allen: Was this offered?

Mr. S. D. L. Jackson: My recollection is it was, and it appears on these pages of the (stenographic) record to which I have alluded, page 5745 and 5744, that that page was presented to the witness Bowman and the witness Bowman disclaimed any knowledge of it and it was not previously offered in evidence. I now offer it.

Mr. Fly: I object to it on the grounds heretofore stated and I would like to have a witness to go into this matter, your Honor.

Judge Allen: Mr. Bowman says 'I never saw this before'. Now, is that the only evidence before us as to what this is?

was interrogated as to when these figures had changed. He stated sometime during the summer, fixed it I believe in the month of July or possibly August. Now, those figures which your Honor has on that sheet 10 now before you are the same figures as the ones that appear in Complainants' Exhibit 116 at page 403. That is dated September 29, 1937; that that compilation that your Honor now has before you on exhibit 926 was prepared.

Furthermore, it now appears from Defendants' Exhibit 153 that the earliest time the Board of Directors had taken any action with respect to anything about this change of [fol. 1903] figures was December 20, 1937, after the witness Bowman had testified, and that a day or two before he had testified the Authority had presented those same figures that they had last spring to the Appropriations Committee of Congress when they were requesting an appropriation of about \$40,000,000.

Now, those are the facts as I recall them that appear now in the record. Consequently it goes to the credibility of the witness Bowman and it goes to the sincerity and to the real intent and purpose of this resolution of December 20, 1937, which was adopted at a time when this case was being tried here in an adversary proceeding, and they attempted to set up, as our view is, they attempted to set up a purported or claimed change. And under the circumstances we think that all of those facts should be brought out in this record.

Mr. Fitts: May it please the Court, I would like just very briefly to supplement that statement, because it is a completely incomplete statement of the testimony of the witness Bowman as it appears in the record. And his entire testimony shows why this proposed exhibit is not rebuttal of anything, because what the witness said was that from April, 1937 through to early this fall there had been constant conferences and changes in the tentative and preliminary designs of the Gilbertsville Dam, not only as to its height but as to other features, and that for several years investigations and conferences had been going on as to site, and as to design features.

This is just one of the difficulties, if I may digress for a moment, it is one of the difficulties that comes into a case of this character where we are trying dams that are not even under construction, and that have not even passed

out of the preliminary design stage. It is impossible to come into Court and present a rigid design of a dam that is still being designed. And the testimony of the witness is that all through the summer of 1937 and up through this fall there was a board of special consultants working on the problem with respect to Gilbertsville, that no decision was reached until this fall, and even that decision of course is subject to change, we don't say it is a final decision, we say it is the latest opinion of the design engineers and of the board of consultants, and it is what the witness says. He says further, which the Court, using again its judicial eyesight knows, that all of the hydraulic engineers in responsible charge were down here in this Court room at the very time these preliminary budget figures were being prepared and presented to the committee. They were not there in Knoxville to check them. The office engineer, according to the statement of the witness Bowman, and the chief budget officer, simply took out the old [fol. 1904] figures on Gilbertsville and put them into the record as the best thing they had because they didn't know, and there was no reason why they should know, they didn't know that the design engineers and the consulting engineers had reached a different conclusion as to the height to which the dam would be built, and there being no board action on the subject, and he made it clear that there had not been any board action on the subject, there having been no board action, they took the last set of figures they had in the office for this and used them.

All of that is clear in the cross-examination and the re-direct examination of the witness. Why there should be any difficulty, why there should be any necessity for presenting as rebuttal, and reflecting on the credibility of that witness, this sort of a paper that is taken from the confidential files of the committee, I am frank to say I cannot see.

Mr. Fly: This case will never turn on five feet more or less on any particular dam. But if it were conceivable that it would, if the question as to just when and how the board of directors came to vote for the first time a final figure of 375, the whole story is set forth here in this exhibit, on page 1076, 1077, 1078, there is the whole story of the added five feet of Gilbertsville Dam.

Mr. S. D. L. Jackson: Now, referring to the record, as to credibility, referring to page 3847, 3848 and 3849 of the (stenographic) record in Mr. Bowman's testimony, to which I alluded in my former statement, he said at the end of the examination on that point, 'I should say that in July or August sometime we arrived at these conclusions.' Now, there is an exhibit from one to two months later which shows entirely different conclusions.

Mr. Fly: That is Mr. Bowman's conclusion. The chief engineer had not acted, the board of directors had not acted. There is no dispute about that.

Judge Allen: It has been offered?

Mr. S. D. L. Jackson: We have offered Exhibit 926.

Judge Allen: You are offering this as an exhibit?

Mr. S. D. L. Jackson: Yes, your Honor.

Judge Allen: Exhibit 926 is excluded. On the ground that it is immaterial.

Mr. S. D. L. Jackson: Your Honor, may I have an exception?

[fol. 1905] Judge Allen: Yes, you may have an exception.

Judge Allen: The Court has another matter to take up with counsel. Certain bulletins, we understood perhaps they were water control bulletins, certain papers were presented in Court by the Authority, relating to the methods of operating Norris and Wheeler Dams, and as we understood the other dams embraced in the Unified Plan. It was our memory that it was testified that there were no rule curves. Perhaps we are wrong on that.

Mr. Fly: I think it was testified, your Honor, that Professor Woodward did not have, for the purposes of his operations, and did not follow a rule curve.

I would not want to state that these various engineers with their slide rules, and pencils, and all that sort of thing have not made calculations with curves of different sorts. That is habitual with the engineers.

Mr. S. D. L. Jackson: My understanding of the testimony does not coincide with the statement made by Mr. Fly. I felt that Mr. Woodward's testimony was somewhat broader than that.

Mr. Fly: Well, it probably was, because he said he paid no attention to any filling curve, and I don't think he had prepared one. And I am sure he said he didn't follow it.

Judge Allen: As we understand the testimony of Mr.

Karr, for instance, it was that Mr. Woodward did not give him rule curves to follow.

Mr. Fly: That is true, that is absolutely true.

Judge Allen: Is there any difference about that?

Mr. S. D. L. Jackson: I do not know as Mr. Karr specifically testified on that subject, if the Court please. Did he?

Mr. Fly: Yes, he did.

Mr. S. D. L. Jackson: I don't believe he did.

Mr. Fly: Mr. Wessenauer, in his calculations, presented [fol. 1906] the filling curve.

Judge Allen: Yes. Some witness made that statement, we were quite sure. Now, whether any resolutions of the Board, resolutions, we are talking about, not minutes, approving recommendations or reports relating to methods of operating Norris or Wheeler Dam-, or the other dams embraced in the Unified Plan, now under construction or recommended for construction by the Authority, or establishing rule curves for the filling or lowering of the reservoirs or relating to water control thereat, and directing the means and manner of water control or prescribing methods, or levels at any of the reservoirs at dams constructed under the Unified Plan,—I have tried to state the gist of this application for subpoena,—are there any resolutions to that effect that are not in evidence?

Mr. Fly: I will state, your Honor, that there are no resolutions on these subjects which are not in evidence. By way of explanation, I would say that some of the bulletins themselves indicated approval of the Board of Directors, I think, but they show on their face that they had been approved by the Board. But in addition to the material which is reflected clearly in this record, there are no resolutions dealing with that subject.

Judge Gore: Are there any resolutions of the directors pertaining to any subject except the sale and transmission of electric energy, are there any other kinds of resolutions in the record?

Mr. Fly: I think all of the resolutions as to the construction of the dams are probably here, your Honor. Offhand I don't recall.

Judge Allen: The resolution is in evidence establishing the committee of which Mr. Woodward and the chief electrical engineer are members?

Mr. Fly: Oh, yes, yes.

Judge Allen: Under which the water control bulletins are issued?

Mr. Fly: That is true.

Judge Allen: That is in evidence.

Mr. Fly: And that same resolution, as your Honor recalls, approved one or two bulletins at the same time.

Judge Allen: Yes.

Mr. Fly: Now, to answer your question further, Judge [fol. 1907] Gore, the subpoenas call for, speaking broadly, for all of the resolutions pertaining to power, and I think all of those have been produced, and I don't think there have been a great many in addition to those which have been produced.

Mr. S. D. L. Jackson: May it please the Court, each of the memoranda or bulletins that appear on Complainants' Exhibit 923 show a notation at the bottom 'Approved by the Board of Directors'. I take it the Board of Directors can only take action by some formal method. Do I understand now that that notation is not correct, and that there is no approval?

Mr. Fly: No, my assertion was that that is correct, and those early bulletins were approved. I think you will find that the bulletins on which that approval is noted carry the Board resolutions right with them. That was at the time of the original organization of the water control committee, I believe.

Mr. S. D. L. Jackson: They are not in evidence.

Mr. Fly: Why, yes, they are.

Mr. S. D. L. Jackson: The resolutions?

Mr. Fly: You will find the resolution is in evidence at full length, setting up the—the resolution setting up the water control committee and approving the first one or two bulletins, and then the later resolutions setting up the water planning department and instructing how they shall operate.

Mr. S. D. L. Jackson: That is not what I am talking about. There are nine sheets on Complainants' Exhibit No. 923 which was handed to us by Mr. O'Brian here a day or two ago, after we had requested the Authority to produce. I think that came at the time that Mr. Karr was on the stand. Now, on those nine sheets there is a notation at the bottom, 'Approved by the Board of Directors'.

Mr. Fly: How many of them have that on them?

Mr. S. D. L. Jackson: Nine.

Mr. Fly: That is right.

Mr. S. D. L. Jackson: I would say those in Exhibit 923. Those in Exhibit 924, which show these bulletins subsequent to either June or July of 1937 bear no such notation.

Mr. Fly: That is correct.

Mr. S. D. L. Jackson: The later ones do not. The ones from June to July of last year, which are contained in [fol. 1908] Exhibit 924 do not bear any notation.

Mr. Fly: No, the Authority delegated to Professor Woodward authority to carry on the operations under general review by the Chief Engineer without Board action. Board action was not taken on those bulletins.

Mr. S. D. L. Jackson: Now, our subpoena calls for the resolutions of the Board of Directors.

Judge Allen: Your subpoena calls for minutes.

Mr. S. D. L. Jackson: That is right, and resolutions.

Judge Allen: The Court is talking about resolutions.

Mr. S. D. L. Jackson: Our subpoena did call for minutes, and we still urge that the subpoena, in calling for minutes, is one which we think we should be permitted to see—the minutes with respect to it, even though the minutes might consist of resolutions and some other material. But there has been nothing produced by the Authority in the way of Board action to show the accuracy or fallacy of this notation on the bottom of these exhibits, and as I understand counsel's statement there is none.

Mr. Fly: Your Honor, if I may have the dates with reference to the notations of Board approval here, and the exhibit number and the date, I will again check those. I don't know whether there are any formal resolutions on this or not. I will be glad to recheck them.

Judge Allen: Those were furnished by the Authority. If you will let Mr. Fly look at them, and get the dates, and check them.

Mr. Fly: Now, is this all?

Mr. S. D. L. Jackson: Also, with respect to the part of the subpoena referring to rule curves, do I understand now that there is no Board action approving any rule curve for any of these dams?

Mr. Fitts: That is correct, none at all. We checked that at the time we delivered you those Board resolutions. There is no Board resolution on the subject.

Mr. S. D. L. Jackson: Then this curve shown on Defendants' Exhibit No. 90 has never had Board approval?

Mr. Fitts: That is correct. The Board has taken no action with respect to the rule curves, or operating levels except that one resolution that you have, which is a different situation.

Judge Allen: That is the resolution authorizing operation in all of those matters?

Mr. Fitts: That is correct.

[fol. 1909] Judge Allen: By the electrical engineer and the water control head?

Mr. Fitts: Water control planning department.

Mr. S. D. L. Jackson: That is the resolution of June, 1936.

Mr. Fitts: Then, of course, there is a subsequent resolution, at the time of the general reorganization which created the water control planning department.

Judge Allen: I am talking of the resolution which incorporated by reference two water bulletins.

Mr. Fitts: That is right, that is the earlier of the two. That created the water control planning committee, and then came the reorganization.

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Mr. S. D. L. Jackson: Now, in connection with this matter that we were discussing a moment ago, I notice that the defendants in producing their water control memoranda and bulletins did not produce water control bulletin No. 3, which is dated December 19, 1936, and which is set forth on one of the pages dated December 19, 1936 of the document that was marked Complainants' Exhibit for identification No. 910, that is this big book of reports of the defendants' stream flow operations, which was identified here some time ago.

Mr. Fly: I don't know, your Honor, I have not checked this particular document.

Mr. S. D. L. Jackson: Yes. If I might assist these gentlemen, they have in an exhibit, No. 923, they have a water control bulletin numbered 5, dated October 24, 1936, and their next one is water control bulletin, numbered 4, dated March 10, 1936. That is a gap of probably five months. And I now want to find out if this one dated December 19, 1936 is one of their water control bulletins?

Mr. Fly: Counsel has called my attention to a document in his possession entitled 'Bulletin' dated December 19, 1936. There is no signature or other heading on it, to indicate clearly from where it came, but I have the explanation

here from Professor Woodward. This was an advance notice of the general principles which would govern the operation of Wheeler reservoir during the winter. It was not issued as an official bulletin, and was not signed by the Committee. As a matter of fact, Wheeler was drawn down to 547, as shown by the record.

Judge Allen: Is Professor Woodward here?

[fol. 1910] Mr. Fly: He is not.

Mr. Fitts: We got that over the telephone. He is not here.

Judge Allen: I am just asking you whether you are willing to concede he would testify to that effect.

Mr. S. D. L. Jackson: I would want to cross examine Professor Woodward on that point, if your Honor please, from some material that we have, which I am perfectly willing at this time to state to the Court.

And if I might be permitted very briefly to do it. I will state that in a hearing before the Subcommittee of the Committee on Agriculture and Forestry, United States Senate,—I am not offering this in evidence, I appreciate the Court's ruling, but in a report, the Tennessee Valley Authority water control operations, January, 1937 flood, by J. H. Wilkerson, associate hydraulic engineer, a report was submitted, which stated 'The Committee on water control operations has issued three bulletins and one memorandum, setting forth general regulations for the control of water through reservoir operations'.

Now, the memorandum referred to in that report is dated December 19, 1936, and is the same memorandum that is in this volume. It says there that the Committee issued it for the control of water, and that was reported to Congress.

Mr. Fly: Mr. Wilkerson, who is Mr. Woodward's chief assistant,—I believe that is correct, isn't it? You are the assistant to Mr. Woodward, and you have to do with the issuance of these bulletins?

Mr. S. D. L. Jackson: Now, just a minute.

Mr. Fly: I am going to offer you a witness, if you will wait a minute.

Mr. S. D. L. Jackson: Let's have him sworn and put on the stand, if you are going to do that."

(Thereupon, JACKSON H. WILKERSON was sworn and took the stand.)

[fol. 1911] "Mr. Fly: I assume this is voluntary testimony, but it will be limited to this one point.

Judge Allen: It will be limited to this one point, and the Court in determining the question which has arisen in the course of rebuttal—

Mr. Fly: There is no direct. I think he is your witness, as a matter of fact.

Judge Allen: Do you want to cross examine him?

Mr. S. D. L. Jackson: I want to ask him if he prepared this report. May I have it?

Judge Martin: What is your name?

The Witness: My name is Jackson H. Wilkerson.

Mr. S. D. L. Jackson: I take it that Mr. Wilkerson is offered for cross examination on this one particular point. Is that it?

Mr. Fly: It is for examination first. You wait, and see if he is hostile, and then ask to cross examine.

Judge Allen: If you wish to cross examine him you may. If not, the Court will examine him and determine whether—

Mr. S. D. L. Jackson: As a matter of fact, if the Court will just ask him, or desire to examine him—I have no desire to take this gentleman as my witness. I am perfectly willing to stand on their statement to Congress.

Judge Allen: Will someone give us the statement that was read here, the one on the card?

Mr. S. D. L. Jackson: The one that Mr. Fly just read?

Mr. Fly: The statement from Mr. Woodward, I just read it.

Judge Allen: Let's have that statement. May I have the card?"

(Statement read as follows:)

"Mr. Fly: Counsel has called my attention to a document in his possession entitled 'bulletin' dated December 19, 1936. There is no signature or other heading on it to indicate clearly from where it came, but I have the explanation here from Professor Woodward. This was an advance notice of the general principles which would govern the operation of Wheeler reservoir during the winter. It was not issued as an official bulletin and was not signed by the Committee. As a matter of fact, Wheeler was drawn down to 547 as shown by the record."

[fol. 1912] "Judge Allen: Now, is this the water control bulletin concerning which you have some question, the bulletin of December 19, 1936?"

Mr. S. D. L. Jackson: That is the one that was not furnished under Exhibit No. 923 as part of Exhibit 923."

[fol. 1913] Examination by the Court:

I believe I recall this bulletin. My position with TVA is river forecaster, with a rating at present of hydraulic engineer. At the time that was issued, I was associate hydraulic engineer for the TVA. In the organization I operate under Mr. Fry, head of the hydraulic data division. Mr. Fry is under Mr. Woodward's division. In the course of my work I report practically daily river conditions and weather conditions and data to Mr. Woodward, or to Mr. Woodward's assistant, Mr. Bowden.

I am familiar with the bulletin of December 19, 1936. As to the conditions under which it was issued, the first time I saw this bulletin in substantially this form, Mr. Woodward handed it to me one day in his office and asked if I approved this method of operation, or concurred with it. I told him I disagreed in one thing, in that he had the rate of draw-down too slow, it was something like about the rate of slower than 2 feet per week. He reconsidered that and changed it to its present form and requested that I publish it with my daily river bulletin. I believe it was not issued as an official bulletin. As to what level Wheeler was drawn down in December at that time, I believe it was lowered to 553 and possibly lower. I am not sure about going lower at that time.

"Judge Allen: Is there anything you want to ask this particular witness, about this particular point?"

Mr. S. D. L. Jackson: Would the Court interrogate as to this point, if he did not prepare this report to Congress, which stated that the committee on water control operations had issued three bulletins and one memorandum, and that the memorandum of December 19, is the memorandum referred to and described in this report.

Judge Allen: What document is that that you read that from?

[fol. 1914] Mr. S. D. L. Jackson: This is from the report of the hearings before the Subcommittee of the Committee on Agriculture and Forestry, United States Senate in the

report submitted to that Committee by the Tennessee Valley Authority.

Judge Allen: That covers all that the Court cares to ask.

Judge Martin: But counsel may examine him.

Judge Allen: If you want to ask him, you can ask him.

Mr. S. D. L. Jackson: As upon cross examination?

Mr. Fly: I don't know why you should make any point on that. Go ahead and get the information.

Mr. S. D. L. Jackson: I didn't call this gentleman.

Mr. Fly: All right, then, after clarifying the one point——

Mr. S. D. L. Jackson: I didn't call him, I don't call him as our witness.

Mr. Fly: Mr. Wilkerson, will you kindly explain to the Court the difference between the official bulletins which bore the number and the signature of Professor Woodward, and these daily river bulletins,—are they? Explain to the Court the difference in having it circulated in the manner in which it was in this case.

Mr. S. D. L. Jackson: Now, I object to interrogation by counsel.

Mr. Fly: Well, you raised this point. Don't you want it clarified?

Mr. S. D. L. Jackson: I want to find out——

Mr. Fly: All right, that is all.

Mr. S. D. L. Jackson: If that purported bulletin which we have is one of their official bulletins."

(The witness was excused.)

"Mr. Fly: If your Honor please, I have had the Board minutes checked regarding the notation of approval of the water control bulletins, and I find in all of the cases mentioned except one, and I have not been able to find that one notation, that there was a formal notation of Board approval. For example, here is the one on June 3, 1937, 'The Board unanimously approved water control bulletin No. 8, [fol. 1915] a true copy of which is labelled exhibit 637-S, as filed with the records of the Authority.' That simple notation occurs with all of them, and I will stipulate as to the one which I don't have, that is July 2nd, 1937, that a similar notation was made in the minutes. Bulletin No. 1 is not covered by these notations, but the Court will recall that when the bulletins themselves were introduced they

carried the resolutions, formal resolutions on the face of them.

Judge Allen: Now, do we understand that it is the professional statement of counsel for the Authority,—or it is our understanding, and are we right in understanding that all of the resolutions covering the matter asked for in the single remaining application for subpoena duces tecum have been produced?

Mr. Fly: That is correct, your Honor, and I might further state regarding that February report that there is no resolution on that. The Board never adopted that, and passed no resolution on it.

Judge Allen: The Court has ruled on that.

Mr. Fly: Mr. Jackson, are you going to offer these now, that you have got them?

Mr. S. D. L. Jackson: I want to take a look at them, if I may, before doing so. Do I understand these are accurate copies of the resolutions?

Mr. Fly: These are copies of the notations taken out of the minutes.

Mr. Fitts: The only thing on the subject.

Mr. S. D. L. Jackson: We have all of the notations on the minutes relating to these water control operations.

Mr. Fly: That is right.

Mr. Fitts: That is correct.

Mr. S. D. L. Jackson: Now, if I may for a minute—

Mr. Fitts: One missing date we were not able to find, but we are willing to agree the same notation—

Mr. S. D. L. Jackson: I am not going to agree as to what might be in the Board's minutes, not having been in gunshot of them during the progress of this trial. There may be a gap. I cannot stipulate it.

Judge Allen: The Court accepts the professional statement of counsel in reference to these matters as it has accepted the professional statement of counsel for the complainants on certain matters.

The application for subpoena duces tecum with reference to the minutes of the Board of Directors as to methods of operating Norris and Wheeler Dams, and all of the other [fol. 1916] matters included in paragraph one of that application, and as to the minutes of the Board of Directors prescribing levels of any of the reservoirs and all of the other matters contained in paragraph two of that application are denied, upon the ground that you have the official

action of the Board on these matters, and upon the further ground that this application was made during the rebuttal, and that it did not come sufficiently in advance to permit of compliance without delaying the trial.

Mr. S. D. L. Jackson: May we have our exception to the Court's ruling?

Judge Allen: You may have your exception.

Mr. S. D. L. Jackson: And may the application for subpoena duces tecum be marked or given the exhibit number, (Complainants' Exhibit 956) and appear in the record?

Mr. Fly: I would also ask, your Honor, that counsel's report to the Court that there were no such resolutions may be understood as a part of the record.

Judge Allen: That may be included in the record as a professional statement of counsel.

Judge Allen: The Court wishes to announce to counsel and to the litigants that, with whatever recess may be necessary and appropriate for supper, or at dawn or at breakfast, we will proceed until all of the evidence in this case is in today."

Counsel for complainants then offered in evidence and the Court received as Complainants' Exhibit 957, copies of resolutions of the Board of Directors of TVA, dated October 26, 1936, March 12, 1937, March 31, 1937, May 5, 1937, and June 3, 1937, furnished by the defendants dealing with the water control bulletins.

Counsel for complainants then offered and the Court received as Complainants' Exhibits 910-a, Water Control Bulletin No. 3 dated December 19, 1930, and 910-b, a sheet captioned "Tennessee Valley Authority Engineering Data Division, February 9, 1937, river stages and rainfall" taken from the document marked Complainants' Exhibit 910.

[fol. 1917] "Mr. Fly: At this time the Government desires to renew each and every one of its motions made heretofore for the dismissal of the case as to each and all of the complainants, as to each and all of the defendants. The Government at this time wishes, further, and does hereby further move for the dismissal of the case as to each and all of the complainants and as to each and all of the defendants, upon the ground that considering the record, the case as a whole, the complainants have failed to make out any cause of action.

Judge Allen: The Court will take the matter under advisement."

Here both sides rested the case and the Court adjourned at 3:45 P. M. to hear final argument at 9:00 A. M. the following day, January 15, 1938.

STATEMENTS RE RULINGS OF COURT

"Judge Allen: The Court has a statement for the record. Throughout the trial from November 15, 1937, through January 14, 1938, the Court has held daily conferences, sometimes several times a day, and even has held long conferences on Saturday and Sunday in chambers. The rulings made on the admission or rejection of evidence as well as on the admission of depositions and the issuance of subpoenas duces tecum are the rulings of the entire Court. The statements made from the bench, unless otherwise indicated in the record, were in general made after consultation with, and in all cases reflect the sentiment of the entire Court.

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Judge Allen: The Court desires to make a statement. In the statement made this morning by the Court, it was not meant to indicate that there was no difference in opinion among the members of the Court as to the scope or limitation of the evidence, but the full Court has concurred in the application of the conclusions reached on these matters."